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New Palladium Precatalysts For Cross-Coupling Reactions

by Nicholas C. Bruno and Stephen L. Buchwald

**Dealloyed Pt core-shell nanoparticles:
Active and durable electrocatalysts for low-temperature
Polymer Electrolyte Membrane Fuel Cells (PEMFCs)**

by Professor Dr. Peter Strasser

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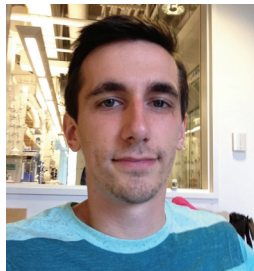


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Biographical Sketches

Stephen L. Buchwald has been a faculty member at MIT since 1984. He is currently the Camille Dreyfus Professor of Chemistry and was the recipient of the 2013 Arthur C. Cope Award. He lives in Newton, MA with his wife and two children, and his cats Rufus and Rocket.



Nicholas C. Bruno was born and raised in California, MD. He received his B.Sc in 2010 from St. Mary's College of Maryland, where he worked under Dr. Andrew S. Koch. He is currently a fourth year graduate student in the Buchwald lab where he has been working on the development of palladium precatalysts for cross-coupling reactions. Outside of chemistry, he is an avid fan of the Baltimore Orioles and Washington DC's NFL team.

Professor Peter Strasser holds a chaired professorship in the Chemical Engineering Division of the Department of Chemistry at the Technical University of Berlin. Prior to his appointment, he was Professor at the Department of Chemical and Biomolecular Engineering at the University of Houston. Before moving to Houston, Prof. Strasser served as Senior Member of staff at Symyx Technologies, Inc., Santa Clara, California. He supervised a research team in the Electronic Materials, Electrocatalysis and the Heterogeneous Catalysis Group.

In 1999, Prof. Strasser earned his doctoral degree in Physical Chemistry and Electrochemistry from the 'Fritz-Haber-Institute' of the Max-Planck-Society, Berlin, Germany, under the direction of the 2007 Chemistry Noble Laureate, Professor Gerhard Ertl. In the same year, he was awarded the 'Otto-Hahn Research Medal' for the 'outstanding dissertation of the year 1999' by the Max-Planck Society.

In 1996, Dr. Strasser was visiting scientist with Sony Central Research, Yokohama, Japan. He studied chemistry at Stanford University (1991-1992), the University of Tuebingen, Germany (1988-1995), and the University of Pisa, Italy (1992-1993), and received his diploma degree (MS) in chemistry in 1995.



Professor Strasser is interested in fundamental and applied aspects of the Materials Science and Electrocatalysis of electrified liquid solid interfaces.

New Palladium Precatalysts For Cross-Coupling Reactions

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Introduction

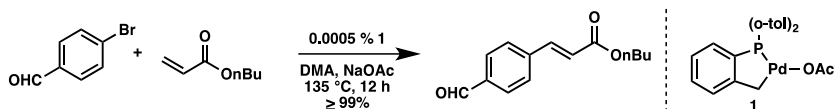
Palladium-catalyzed cross-coupling reactions have become common tools for C-C and C-X bond formation in academic and industrial settings.¹⁻² Privileged ligand scaffolds have emerged that can effectively support a vast range of transformations.³ However, as more complex cross-coupling reactions are explored, the method for generation of the catalytically active $L_nPd(0)$ species has often proven to be pivotal to the success of a cross-coupling reaction.

Many traditional palladium sources can have significant problems in generating active catalysts. Stable $Pd(0)$ sources such as $Pd_n(dba)_m$ contain dibenzylideneacetone (dba) ligands that can impede the catalytic cycle.⁴ These Pd species can also contain varying degrees of free dba and palladium nanoparticles.⁵ $Pd(II)$ sources such as $Pd(OAc)_2$ and $PdCl_2$ need to be reduced to $Pd(0)$ *in-situ* before entering a $Pd(0)$ - $Pd(II)$ cross-coupling cycle. Other Pd sources such as allyl and $[(\text{cinnamyl})PdCl]_2$ dimers and $Pd(PPh_3)_4$ are thermally unstable.

One solution to the issue of palladium activation is through the use of palladium precatalysts.⁶⁻⁷ Precatalysts are generally pre-formed $Pd(II)$ and $Pd(0)$ species such as palladacycles and $Pd^0[P(tBu)_3]_2$ that exhibit air and moisture stability. Precatalysts activate under general reaction conditions or with external additives to provide the necessary $L_nPd(0)$ species to enter the catalytic cycle.

Historical Context

In 1995 Hermann and Beller reported the synthesis and utility of palladacycle **1**, generated from the cyclometallation of $P(o\text{-tol})_3$ with $Pd(OAc)_2$ at room temperature in toluene for 16 h.⁸⁻⁹ Palladacycle **1** exhibited unprecedented catalytic activity in Heck coupling, achieving TONs as high as 200,000 in some cases (Scheme 1). Employing **1** was markedly more effective than the combination of $P(o\text{-tol})_3$ and $Pd(OAc)_2$. This was the first example of developing a palladacycle specifically for catalysis and was the first glimpse of the potential of palladacyclic precatalysts.



Scheme 1. Heck coupling of 4-bromobenzaldehyde and n-butyl acrylate with **1**

The work of Hermann and Beller sparked considerable interest in developing palladacycles for catalysis. As a result many palladacyclic precatalysts have emerged since 1995. Some are simply cyclopalladated ligands such as **2**¹⁰ and **3**¹¹ which are effective in Heck coupling and C-N cross-coupling, respectively. Others are palladacycles of 2-(dimethylamino)biphenyl **4**¹² and N, N-dimethylbenzyl amine **5**,¹³ which could be ligated with various phosphine and N-heterocyclic carbene (NHC) ligands (Figure 1). All of these precatalysts exhibited good reactivity in coupling reactions but required one catalytic cycle, β -hydride elimination, or an exogenous additive to activate.

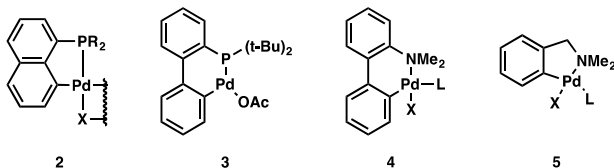
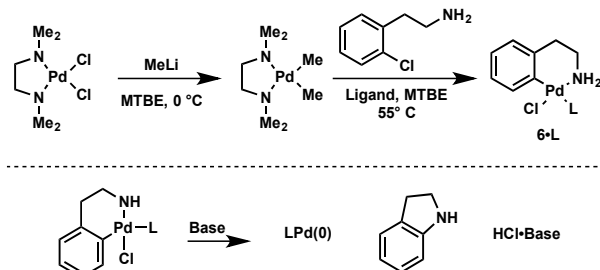


Figure 1. Representative palladacycles utilized in Pd cross-coupling reactions.

First Generation Precatalysts

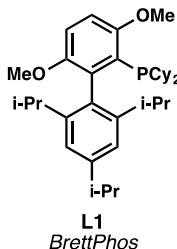
In 2007, we isolated a stable, primary amine-bound oxidative addition complex.¹⁴ Inspired by this discovery and the success of palladacyclic precatalysts, we endeavored to develop a general precatalyst compatible with a broad spectrum of ligands. This led to the development of **6**, an intramolecularly amine-coordinated oxidative addition complex that could bear a variety of phosphine ligands.¹⁵ The success of **6** to generate the desired LPd(0) species was contingent on the deprotonation of the palladium-bound amine, which occurred readily, followed by subsequent reductive elimination to generate LPd(0), indoline, and a salt.

The initial synthesis of **6** is depicted in Scheme 2 and involves the generation of the thermally sensitive (tmeda)PdMe₂, followed by its reaction with 2-chlorophenethylamine in the presence of ligand. Since the first published synthesis of **6**, Vicente and coworkers reported an alternative synthesis that proceeds via C-H activation, utilizing Pd(OAc)₂ and phenethylammonium triflate.¹⁶

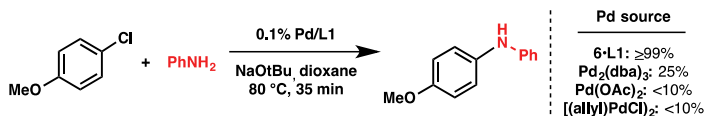


Scheme 2. Preparation of palladacyclic precatalysts **6•L** and their mode of activation.

Precatalyst **6** in Cross-Coupling Reactions



To evaluate the performance of **6** in cross coupling reactions, its use was compared to traditional palladium sources such as [(allyl)PdCl]₂, Pd₂(dba)₃, and Pd(OAc)₂/PhB(OH)₂ in the arylation of aniline with 4-chloroanisole with **L1** as the supporting ligand. BrettPhos, **L1**, has been shown to be an effective and selective supporting ligand in the arylation of primary amines. As seen in Figure 1, **6•L1** provided an extremely active palladium source, reaching full conversion of aryl halide in 35 minutes while none of the other sources provided over 25% conversion. Further exploiting the high reactivity of precatalyst **6•L1**, aryl chlorides were combined with electron poor anilines, conventionally difficult coupling partners. A range of electron poor anilines were coupled successfully, including the first examples of 2-NO₂, 2-CO₂Et, 4-CF₃, and 4-CN anilines with aryl chlorides.



Scheme 3. Arylation of aniline with 4-chloroanisole with different Pd sources and **L1** as the supporting ligand.

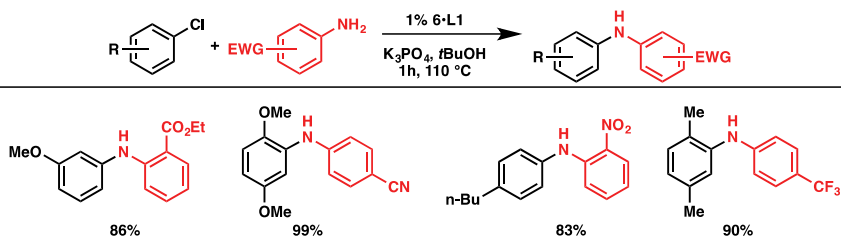
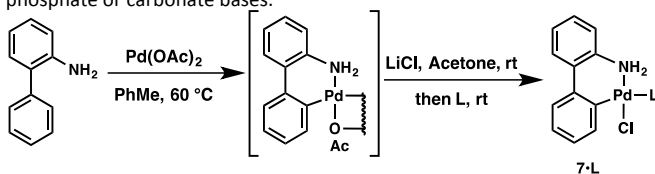


Table 1. Arylation of electron-poor anilines with aryl chlorides by **6•L1**.

Precatalysts **6** provide additional benefits in generating LPd(0) compared to traditional palladium sources. They were found to be efficient in arylations of primary and secondary amines,¹⁷ aminations of unprotected heteroaryl halides,¹⁸⁻¹⁹ α -arylations,²⁰ and continuous flow chemistry.²¹⁻²² Additionally, precatalyst activation of **6•L** and subsequent oxidative addition of aryl chlorides could occur at temperatures as low as -40 °C with LHMDs. Additionally, the clean generation of LPd(0) with **6** enabled the first Hammett study of the oxidative addition of aryl chlorides with monodentate supporting ligands.¹⁵

Second Generation Precatalysts

While an improvement from traditional palladium sources, precatalysts **6** still suffered from inherent drawbacks, one of the most significant being their inability to activate with weak base at room temperature. We began investigating alternative precatalyst scaffolds that retained the stability and ease of use of **6** while allowing them to activate at lower temperature. Encouraged by the work of Albert in their development of triphenylphosphine-ligated palladacycles of 2-aminobiphenyl,²³⁻²⁴ we hypothesized that using 2-aminobiphenyl as the palladacycle backbone in place of phenethylamine, the NH₂ of the palladium precatalyst would be much more acidic, and thus, a more readily-activated palladium precatalyst. A series of precatalysts bearing biaryl dialkyl phosphines, **7•L**, were prepared in a convenient, one-pot procedure from the cyclopalladation of 2-aminobiphenyl by palladium acetate, followed by ion exchange with lithium chloride, and phosphine ligation (Scheme 4).²⁵ These precatalysts proved to be much more readily-activated, generating LPd(0) at room temperature with phosphate or carbonate bases.



Scheme 3. One-pot preparation of precatalysts **7**

The ready activation of precatalyst **7•L2** and the resulting LPd(0) was utilized in the Suzuki-Miyaura coupling of the polyfluorophenylboronic acids and heteroaryl-2-boronic acids. These boronic acids represent structurally interesting coupling partners for pharmaceutical and agrochemical synthesis as well as in natural product and materials synthesis. However they are prone to rapid protodeboronation, rendering the use of higher temperatures or long reaction times problematic. With 2 – 3 mol % **7•L2**, these unstable boronic acids could be coupled to a range of structurally diverse aryl halides in short reaction times (0.5 – 2 h) under mild conditions (ambient temperature – 40 °C) in good to excellent yields. The utilization of **7•L2** was pivotal in the first general method for the Suzuki-Miyaura coupling of these structurally important boronic acids.

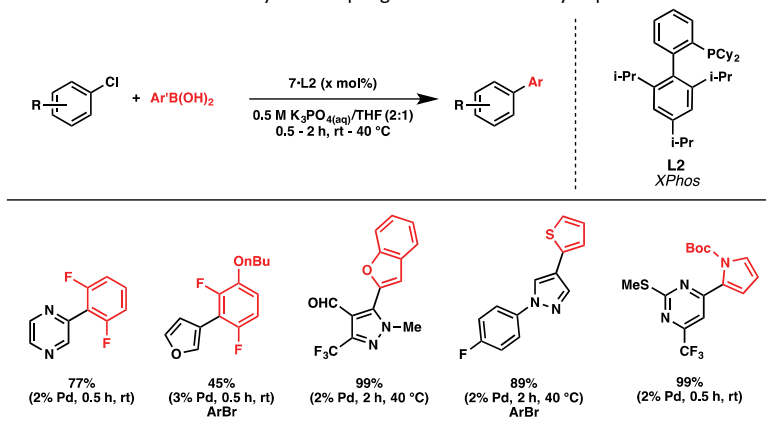


Table 2. Suzuki-Miyaura coupling of unstable boronic acids with **7•L2**

Precatalysts **7** have found use in a wide array of cross-coupling methodologies. They have been utilized in the first general method for the Suzuki-Miyaura coupling of unprotected, 5-membered heterocycles,²⁶ a myriad of Suzuki-Miyaura couplings with aryl- and alkyl-BF₃K salts,²⁷⁻²⁹ borylations of aryl halides,³⁰ alkylation in continuous flow,³¹ and C-H arylation.³²

Third Generation Precatalysts

Generations one and two of our precatalysts were of great use in cross-coupling chemistry. However, the preparation of **6** required Schlenk techniques and the use of unstable intermediates or the use of triflic acid. Precatalyst **7** could not incorporate bulkier biaryl dialkylphosphines, including **L1**, an important ligand in C-N bond formation. As a result, we developed a third generation precatalyst to address the issues of previous generations. By replacing the chloride ligand in **7** with the non-coordinating and more electron-poor methanesulfonate ligand, a new family of precatalysts was prepared that exhibited the broadest ligand scope to date.³³ Additionally, they were highly soluble and stable in common organic solvents while still retaining the ease of preparation of **7**. Precatalysts of type **9** could all be generated from the common intermediate **8**. Complex **9** could be prepared with a range of ligands (Table 2) in uniformly high yields. Precatalysts **9** have also been shown to be at least as effective as previous generations of precatalysts in catalysis. Demonstrating the practicality and scalability of this procedure, μ -OMs dimer **8** has been synthesized at a 400 g scale.

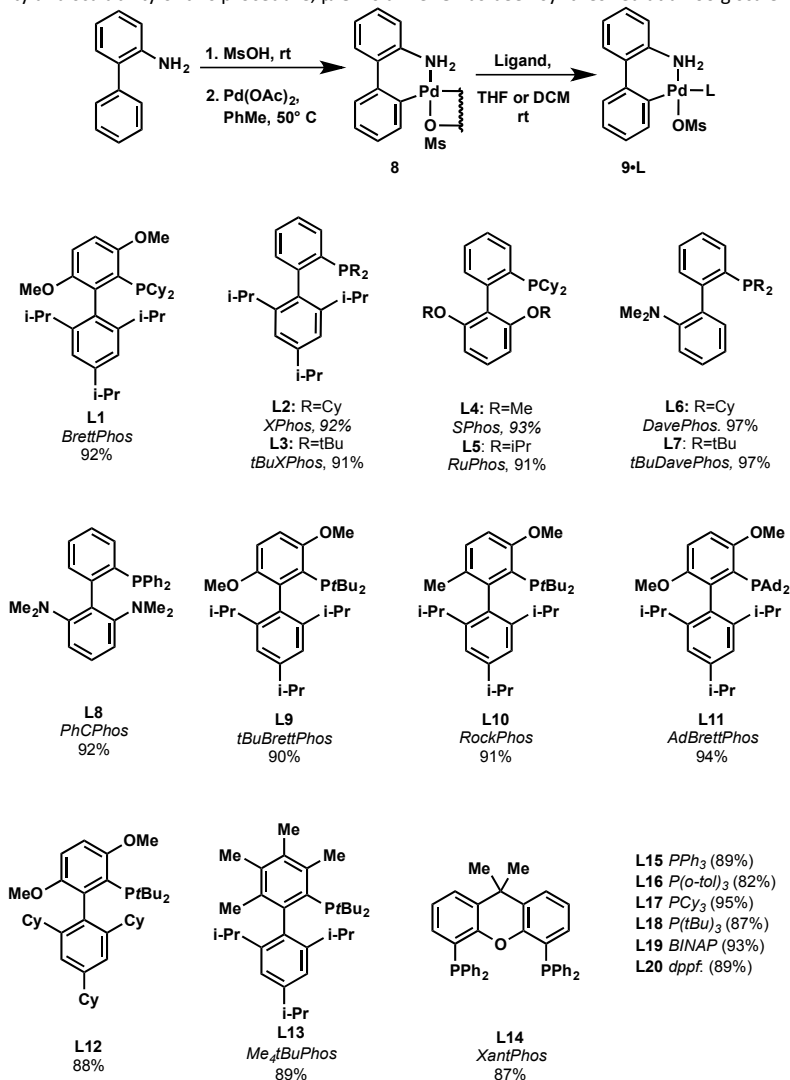
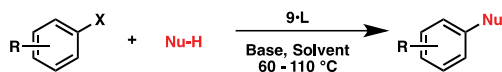


Table 3. Preparation and representative examples of precatalyst **9**

Precatalysts for Bulky Biaryl Di-tert-Butyl Phosphines

Precatalysts **9** were the first to be able to incorporate the extremely bulky biaryl di-tert-butyl phosphine ligands **L10-L14**.³⁴ Previous generations of precatalysts could not accommodate these ligands, presumably due to the combination of their steric bulk and the chloride ligands' inability to dissociate. Prior to the development of **9**, preactivation of the ligand and palladium source was necessary through water activation with Pd(OAc)₂ or prestirring the ligand with Pd₂(dba)₃ at elevated temperatures. This was not ideal as these procedures required an additional operation in an ancillary reaction vessel as well as additional equivalents of ligand relative to palladium. The use of **9•L10 – 9•L14** avoid these issues. By employing a palladium source preligated with these ligands, we see good activity in a range of C-N and C-O bond-forming reactions without preactivation or added ligand (Table 4).



Entry	ArX	Nu-H	Product	Pd %	Ligand	Yield
1				2%	L10	96%
2				2%	L10	77%
3				2%	L12	90%
4				2%	L12	78%
5				1%	L9	92%
6				1%	L9	92%

Table 4. Arylation of amides and alcohols with **9•L10 – 9•L14**.

In-Situ Precatalyst Generation

Since precatalysts of type **9** can be formed quickly in a range of solvents and exhibit good solubility, we developed a protocol for generating them *in situ* for the screening of ligands in a palladium-catalyzed coupling reaction. This *in-situ* catalyst generation protocol was evaluated in the Suzuki-Miyaura coupling of 4-chloro-3-methylanisole and 2, 6-difluorophenylboronic acid. Vials of palladium source and ligand were aged for 10 minutes in 1 mL of THF and directly added to the reaction mixture, followed by aqueous base. As depicted in Table 3, XPhos was the optimal ligand for this reaction, with μ -OMs dimer **8** showing the highest catalytic activity, even when compared to similar 2-aminobiphenylpalladium dimers. Pd(OAc)₂ and Pd₂(dba)₃ provided little product (Table 4).³³

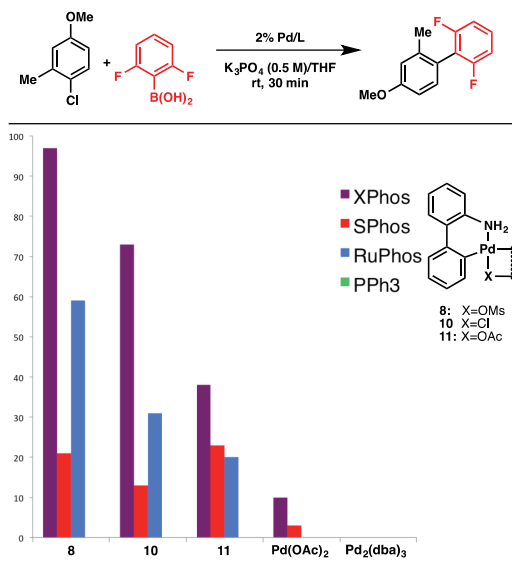


Table 5. Evaluation of palladium sources and ligands for *in-situ* catalyst generation in Suzuki-Miyaura coupling.

Precatalysts in Aromatic Cyanation

Aromatic nitriles are useful synthetic intermediates, pharmaceutical targets, and potential tracers for positron emission topography. We recently reported the cyanation of aryl chlorides and bromides with the non-toxic cyanide source $\text{K}_3[\text{Fe}(\text{CN})_6]$.³⁵ While there have been previous reports of catalytic processes, they all employ long reaction times, high temperatures, and exhibit limited substrate scopes. Our procedure circumvented these limitations through the employment of precatalyst **8** and the monodentate ligands **L2**, **L3**, and **L9**, which gave much higher yields than the traditional $[(\text{allyl})\text{PdCl}]_2$, $\text{Pd}_2(\text{dba})_3$ and $\text{Pd}(\text{OAc})_2$ palladium sources. The reaction showed a broad substrate scope, tolerating a range of functional groups, 5-membered heterocycles, and N-H containing heterocycles (Table 5).

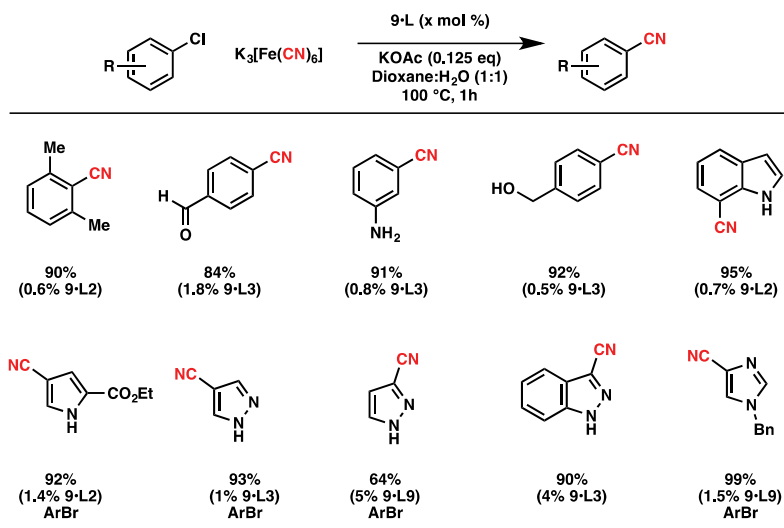
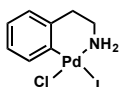


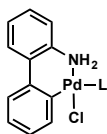
Table 5. Aromatic cyanation of aryl halides with **9**.

Palladacycle Precatalysts



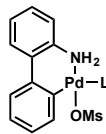
**First
Generation**

- Compatible with bulky ligands
- 3 step preparation
- Unstable intermediates
- Short life in solution



**Second
Generation**

- Simple one pot preparation
- Pd(OAc)₂ as Pd source
- Not compatible with bulkier ligands
- Poor solubility and short life in solution



**Third
Generation**

- Simple preparation with stable isolable intermediate
- Compatible with bulky ligands
- Can be prepared *in-situ*
- Long solution life (≥ 1 month)

Mode of Activation

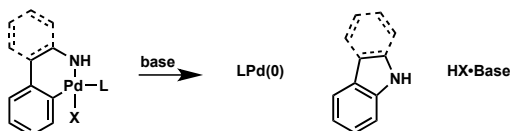


Table 6. A brief summary of precatalyst generations developed in our lab and their general mode of activation.

Conclusion

In conclusion, the use of preformed palladium precatalysts containing phosphine ligands are an efficient means to generate the desired $L_nPd(0)$ species compared to traditional means of catalyst generation with separate Pd and ligand sources. We have developed three generations of palladacyclic precatalysts to address the issues of catalyst activation (Table 6). Our third generation methanesulfonate precatalysts are readily activated, incorporate the broadest range of ligands to date and have a facile preparation that is amenable to large-scale synthesis. Additionally, by generating $LPd(0)$ more efficiently than traditional palladium sources, our palladacyclic precatalysts have made possible methodologies that would not otherwise be feasible. We anticipate that the implementation of precatalysts will greatly improve the scope of palladium catalyzed cross-coupling reactions.

Acknowledgments

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References:

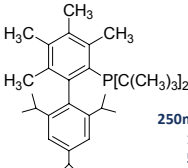
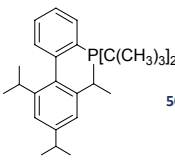
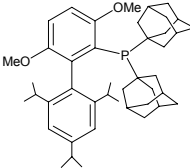
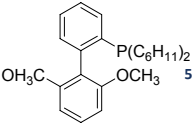
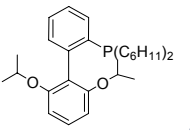
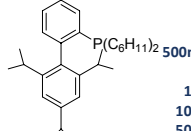
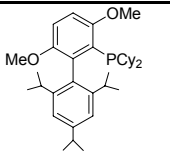
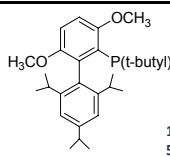
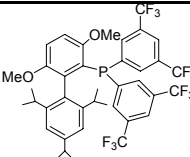
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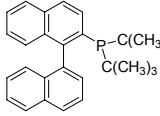
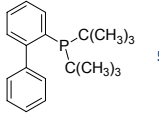
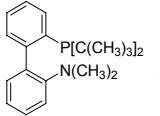
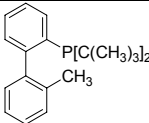
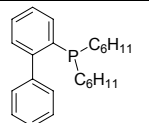
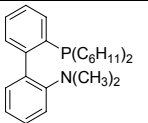
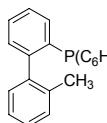
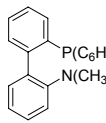
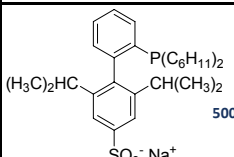
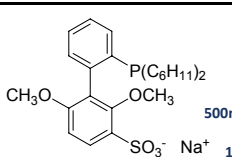
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Buchwald Ligands & Kits

96-5485 Mini Kit 1 (contains more recently developed ligands)

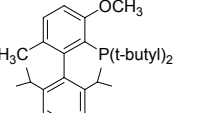
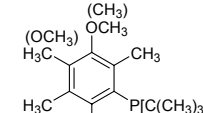
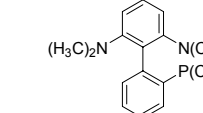
 250mg 1g 5g	 500mg 2g 10g 50g	 100mg 500mg 2g
Me4 t-butylXPhos	t-butylXPhos	AdBrettPhos
15-1051 857356-94-6	15-1052 564483-19-8	15-1138 1160861-59-5
 500mg 2g 10g 50g	 1g 5g 25g 100g	 500mg 2g 10g 100g 500g
SPhos	RuPhos	XPhos
15-1143 657408-07-6	15-1146 787618-22-8	15-1149 564483-18-7
 250mg 1g 5g 25g	 100mg 500mg	 100mg 500mg 2g
BrettPhos	t-butylBrettPhos	JackiePhos
15-1152 1070663-78-3	15-1164 1160861-53-9	15-1157 1160861-60-8

96-5490 Mini Kit 2 (contains more mature ligands)

 250mg 1g 5g	 500mg 2g 10g 50g	 500mg 2g 10g
TrixiePhos	JohnPhos	tBuDavePhos
15-1043 255836-67-0	15-1045 224311-51-7	15-1048 224311-49-3
 500mg 2g 10g 50g	 1g 5g 25g 100g	 500mg 2g 10g 50g
tBuMePhos	CyJohnPhos	DavePhos
15-1049 255837-19-5	15-1140 247940-06-3	15-1145 213697-53-1
 500mg 2g 10g 50g	 500mg 2g 10g	Kit contains smallest unit size. Components available for individual sale.
MePhos	PhDavePhos	
15-1148 251320-86-2	15-1745 240417-00-9	
 500mg 2g	 500mg 2g 10g	Review Article (general uses): <i>Adv. Synth. Catal.</i> , 2004 , 346, 1599. <i>Chem. Sci.</i> , 2011 , 2, 27-50. Patents: US 6,395,916, US 6,307,087.
XPhos-SO₃Na	water soluble SPhos	
15-1135 870245-84-4	15-1142 870245-75-3	

Buchwald Ligands & Kits (cont.)

Also Available

					
100mg 500mg 2g	250mg 1g 5g	1g 5g			
RockPhos	NEW	NEW	CPhos	NEW	
15-1168	1262046-34-3	15-1063	1359986-21-2	15-1147	1160556-64-8

Bulk quantities available. Please inquire.

Review Article (general uses):
Adv. Synth. Catal., **2004**, 346, 1599.
Chem. Sci., **2011**, 2, 27-50.

Patents: US 6,395,916, US 6,307,087.

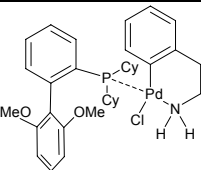
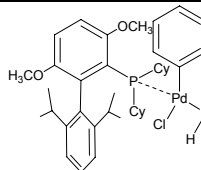
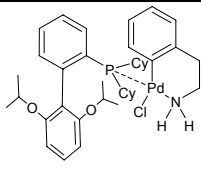
96-5500 **Buchwald Biaryl Phosphine Ligand Master Kit**
 for aromatic carbon-heteroatom bond formation and Suzuki Coupling.

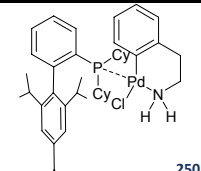
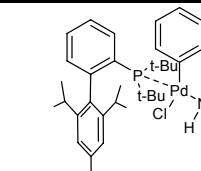
96-5485 **Buchwald Biaryl Phosphine Ligand Mini Kit 1**
(contains more recently developed ligands)
 for aromatic carbon-heteroatom bond formation and Suzuki Coupling.

96-5490 **Buchwald Biaryl Phosphine Ligand Mini Kit 2**
(contains more mature ligands)
 for aromatic carbon-heteroatom bond formation and Suzuki Coupling.

Buchwald Palladacycles & Kits

96-5503 **Buchwald Palladacycle Precatalyst Kit 1**
(chloro-, 2-aminoethylphenyl- Palladacycles)
 Contains the smallest size unit of the following items:

			
250mg 1g 5g	500mg 2g 10g 50g	100mg 500mg 2g 10g	
(from SPhos 15-1143)	(from BrettPhos 15-1152)	(from RuPhos 15-1146)	
46-0269	1028206-58-7	46-0266	1028206-60-1

		Note: Patents: US 6,395,916, US 6,307,087. Components available for individual sale.	
250mg 1g 5g	100mg 500mg 2g 10g		
(from XPhos 15-1149)	(from t-BuXPhos 15-1052)		
46-0268	1028206-56-5		46-0264

1st Generation 96-5503 Buchwald Palladacycle Precatalyst Kit 1
 (chloro-, 2-aminoethylphenyl- Palladacycles)

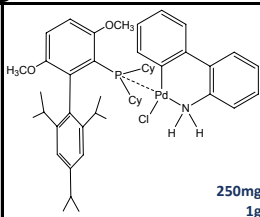
Buchwald Palladacycles & Kits (cont.)

96-5508
Buchwald Palladacycle Precatalyst Kit 3 (Chloro- 2'-amino-1,1'-biphenyl-2-yl Palladacycles)

NEW →

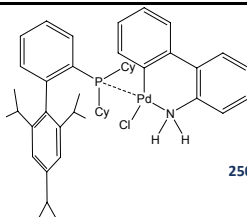
Contains the smallest units of the following items:

2nd Generation-96-5508 Buchwald Palladacycle Precatalyst Kit 3
 (chloro- 2'-amino-1,1'-biphenyl-2-yl Palladacycles)


 250mg
1g

(from XPhos 15-1149)

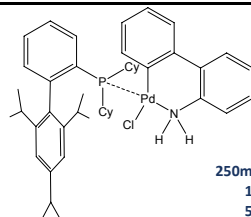
46-0281


 250mg
1g
5g

(from SPhos 15-1143)

46-0283

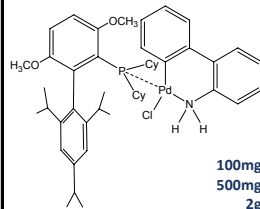
1375325-64-6


 250mg
1g
5g

(from RuPhos 15-1146)

46-0286

1375325-68-0


 100mg
500mg
2g

(from BrettPhos 15-1152)

46-0292

Note: Patents:
 US 6,395,916, US 6,307,087.

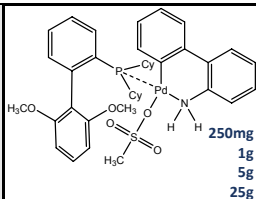
Components available
 for individual sale.

96-5505
Buchwald Palladacycle Precatalyst Kit 2 (Methanesulfonato- Palladacycles)

NEW →

Contains the smallest unit of the following items:

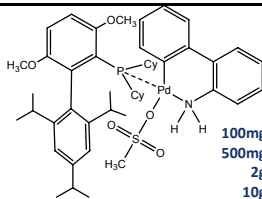
3rd Generation - 96-5505 Buchwald Palladacycle Precatalyst Kit 2
 (Methanesulfonato- Palladacycles)


 250mg
1g
5g
25g

(from SPhos 15-1143)

46-0318

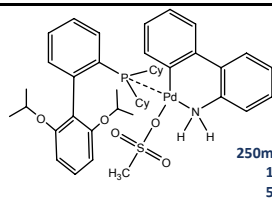
1445085-82-4


 100mg
500mg
2g
10g

(from BrettPhos 15-1152)

46-0322

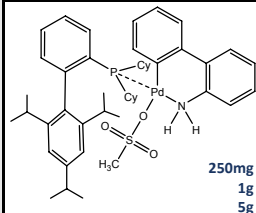
1470372-59-8


 250mg
1g
5g

(from RuPhos 15-1146)

46-0314

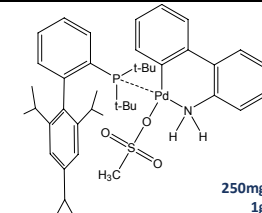
1445085-77-7


 250mg
1g
5g

(from XPhos 15-1149)

46-0320

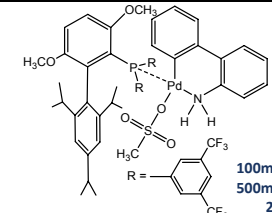
1445085-55-1


 250mg
1g

(from t-BuXPhos 15-1052)

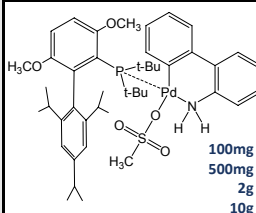
46-0323

1447963-75-8


 100mg
500mg
2g

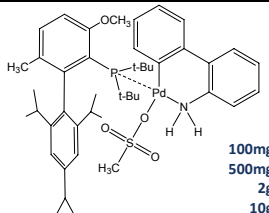
(from JackiePhos 15-1157)

46-0340


 100mg
500mg
2g
10g

(from t-butylBrettPhos)

46-0325


 100mg
500mg
2g
10g

(from RockPhos)

46-0335

Note: Patents:
 PCT/US2013/030779,
 US Serial No. 13/799620

Components available
 for individual sale.

Buchwald AdMixtures

46-0367	Chloro{[BrettPhos][2-(2-aminoethylphenyl)palladium(II)]}/	100mg
	[BrettPhos] admixture (molar PdP/P = 1:1)	500mg
	white powdr.	

Technical Note:

1. See 46-0267 (page 14).

46-0364	Chloro{[t-butylXPhos][2-(2-aminoethylphenyl)palladium(II)]}/	100mg
	[t-butylXPhos] admixture (molar PdP/P = 1:1)	500mg
	white powdr.	

Technical Note:

1. See 46-0264 (Visit www.strem.com).

46-0366	Chloro{[RuPhos][2-(2-aminoethylphenyl)palladium(II)]}/	100mg
	[RuPhos] admixture (molar PdP/P = 1:1)	500mg
	white powdr.	

Technical Note:

1. See 46-0266 (Visit www.strem.com).

46-0369	Chloro{[S-Phos][2-(2-aminoethylphenyl)palladium(II)]}/	250mg
	[S-Phos] admixture (molar PdP/P = 1:1)	1g
	white powdr.	

Technical Note:

1. See 46-0269 (Visit www.strem.com).

46-0368	Chloro{[X-Phos][2-(2-aminoethylphenyl)palladium(II)]}/	250mg
	[X-Phos] admixture (molar PdP/P = 1:1)	1g
	white powdr.	

Technical Note:

1. See 46-0268 (Visit www.strem.com).

46-2033	Palladium(II) acetate/2-dicyclohexylphosphino-2,6-dimethoxy-1,1'-biphenyl (SPhos)/potassium phosphate admixture	5 x 1vial
	[CatKit single-use vials - 1.96 wt% Pd(OAc)₂]	25 x 1vial
	off-white powdr.	

Note: Weight-percent of components: 1.96 wt% palladium acetate; 7.17 wt% phosphine ligand; 90.8 wt% potassium phosphate Kit of CatKits - Single-Use Vials for low catalyst loading experiments Kit component. (Visit www.strem.com).

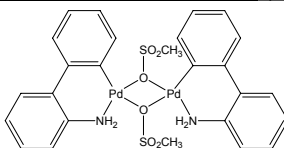
Technical Note:

1. Convenient, pre-weighed vial of palladium catalyst/base admixture useful for screening reactions. The vial contains 453mg of admixture, which will deliver 4 mole% of palladium catalyst and 2 equivalents of base, to a reaction using 1 mmole of substrate.

Note: Patents: US 6,395,916, US 6,307,087

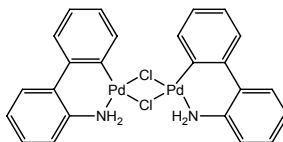
PALLADIUM Compounds

46-1558 **(2'-Amino-1,1'-biphenyl-2-yl) methanesulfonatopalladium(II) dimer, min. 98%** [1435520-65-2]
 $C_{26}H_{24}N_2O_6Pd_2S_2$; FW: 739.47;
 off-white to tan powdr.



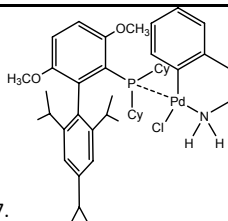
250mg
1g

46-1560 **Chloro(2'-amino-1,1'-biphenyl-2-yl) palladium(II) dimer, min. 98%** [847616-85-7]
 $C_{24}H_{20}Cl_2N_2Pd_2$; FW: 620.17;
 pale gray powdr.



250mg
1g

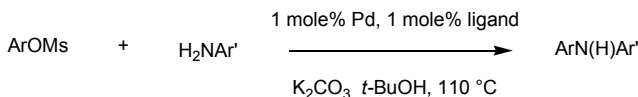
46-0267 **Chloro[2-(dicyclohexylphosphino)-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl][2-(2-aminoethyl)phenyl] palladium(II), min. 98%** [BrettPhos Palladacycle] [1148148-01-9]
 $C_{43}H_{63}ClNO_2PPd$; FW: 798.81; white powdr.
 Note: Patents US 6,395,916, US 6,307,087.
 Buchwald Palladacycle Precatalyst Kit 1 Component. See (page 11).



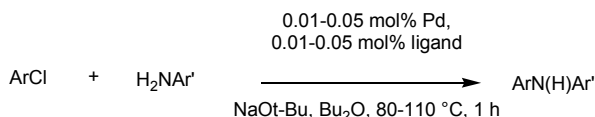
100mg
500mg
2g
10g

Technical Notes:

1. Catalyst for cross-coupling reactions using aryl mesylates with electron-deficient anilines.
2. Catalyst for rapid C-N bond-forming process at low catalyst loading.



Tech. Note (1)
Ref. (1)

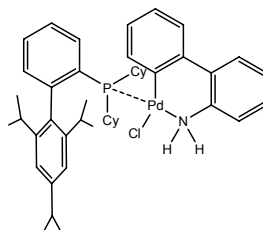


Tech. Note (2)
Ref. (1)

References:

1. *J. Am. Chem. Soc.*, **2008**, *130*, 13552.
2. *Chem. Sci.*, **2011**, *2*, 27-50.

46-0281 **Chloro[2-(dicyclohexylphosphino)-2',4',6'-tri-*i*-propyl-1,1'-biphenyl] palladium(II), min. 98%** [XPhos Palladacycle] [1310584-14-5]
 $C_{45}H_{59}ClNPPd$; FW: 786.80;
 white powdr.
 Note: Patents: US 6,395,916, US 6,307,087. Buchwald Palladacycle Precatalyst Kit 3 component. See (page 12).



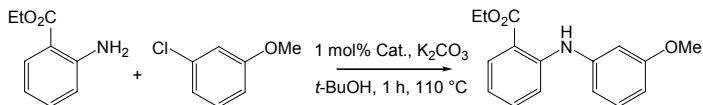
250mg
1g

Technical Note:

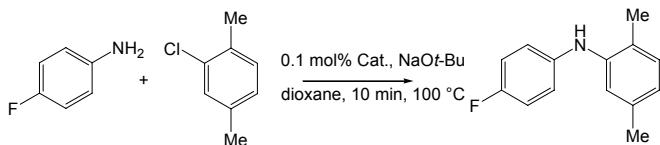
1. Palladium precatalyst for fast Suzuki-Miyaura coupling reactions of unstable polyfluorophenyl and 2-heteroaryl boronic acids.

PALLADIUM Compounds

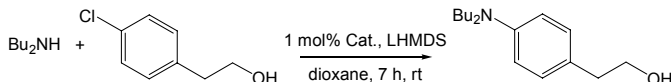
46-0281 **Chloro(2-dicyclohexylphosphino-2',4',6'-tri-*i*-propyl-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [XPhos Palladacycle] [1310584-14-5]**
NEW→
(cont.)



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (1)

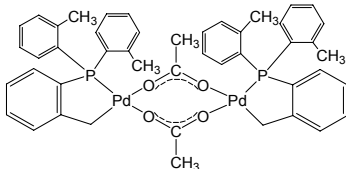


Tech. Note (3)
Ref. (1)

Reference:

1. *J. Am. Chem. Soc.*, **2010**, *132*, 14073.

46-0290 **trans-Di(μ-acetato)bis[o-(di-*o*-tolylphosphino)benzyl]dipalladium(II), 97+% [cataCXium® C] [172418-32-5]**
 $C_{21}H_{20}PPd(C_2H_3O_2)_2PdPC_{21}H_{20}$
 FW: 937.65; yellow xtl.

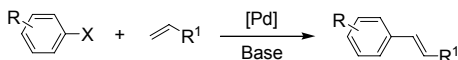


250mg
 1g
 5g

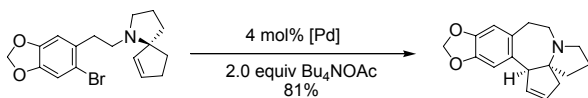
Note: Sold in collaboration with Solvias for research purposes.
 German Patent No. 4421753 granted to Solvias. Solvias
 cataCXium® Ligand Kit component. Visit www.strem.com.

Technical Notes:

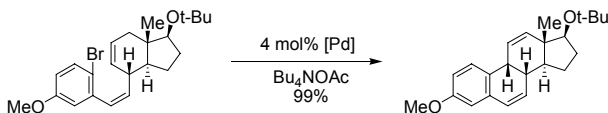
1. Heck olefination of haloarenes.
2. German Patent No. 4421753 granted to Degussa.



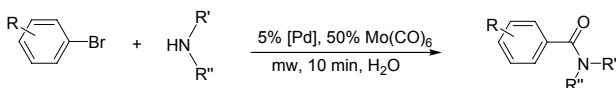
X = Cl, Br Base = $N(C_2H_5)_3$, K_2CO_3 , NaOAc



Ref. (2)



Ref. (3)



Ref. (4)

PALLADIUM Compounds

46-0290 **trans-Di(μ -acetato)bis[o-(di-o-tolylphosphino)benzyl]dipalladium(II), 97+% [cataCXium® C] (cont.)** [172418-32-5]

References:

1. *Angew. Chem. Int. Ed.*, **1995**, 34, 1844.
2. *J. Am. Chem. Soc.*, **1999**, 121, 10264.
3. *J. Am. Chem. Soc.*, **1998**, 120, 8971.
4. *Org. Lett.*, **2005**, 7, 3327.

46-0325 **Methanesulfonato(2-(di-*t*-butylphosphino)-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [t-butylBrettPhos Palladacycle]**

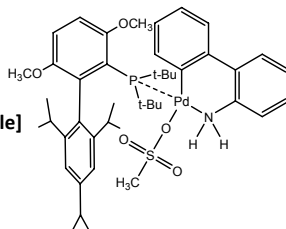
NEW→

C₄₄H₆₂NO₅PPdS; FW: 854.43;

red-brown powdr.

Note: Patents: PCT/US2013/030779,

US Serial No. 13/799620



100mg

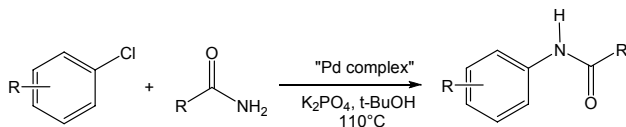
500mg

2g

10g

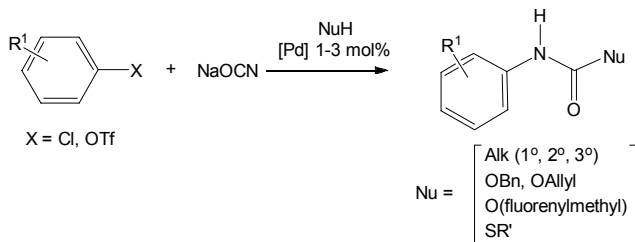
Technical Notes:

1. Palladium catalyst used for the arylation of primary amides.
2. Palladium catalyst used for the synthesis of N-aryl carbamates.
3. Palladium catalyst used for the N-monoarylation of amidines.
4. Palladium catalyst used for the cross-coupling of aryl chlorides and triflates with sodium cyanate – a practical synthesis of unsymmetrical ureas.
5. Palladium catalyst used in the synthesis of imidazo[4,5-b]pyridines and imidazo[4,5]pyrazines through amidation of 2-chloro-3-amino-heterocycles.
6. Palladium catalyst used in the N-arylation of 2-aminothiazoles.
7. Palladium catalyst used in the synthesis of diaryl ethers under mild conditions.



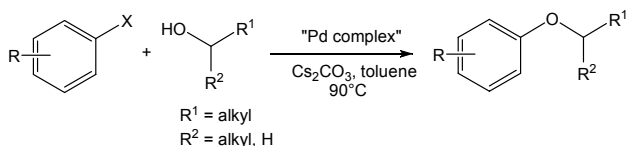
Tech. Note (1)

Ref. (1)



Tech. Note (2)

Ref. (2)

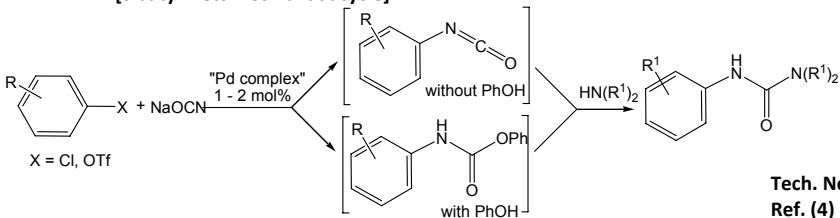


Tech. Note (3)

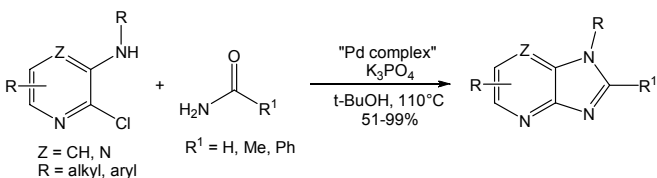
Ref. (3)

PALLADIUM Compounds

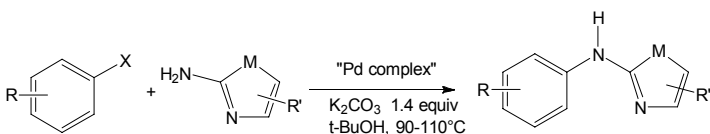
46-0325 **Methanesulfonato(2-(di-*t*-butyl-phosphino)-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [t-butylBrettPhos Palladacycle]**



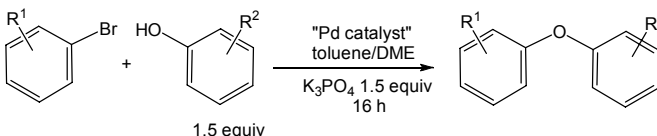
Tech. Note (4)
Ref. (4)



Tech. Note (5)
Ref. (5)



Tech. Note (6)
Ref. (6)



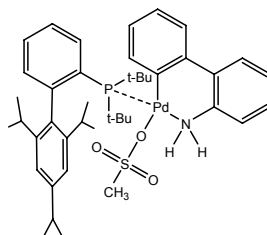
Tech. Note (7)
Ref. (7)

References:

1. *Org. Lett.*, **2013**, *15*, 2876.
2. *Org. Lett.*, **2013**, *15*, 1394.
3. *Org. Lett.*, **2012**, *14*, 3800.
4. *J. Am. Chem. Soc.*, **2012**, *134*, 11132.
5. *Org. Lett.*, **2012**, *14*, 1764.
6. *Org. Lett.*, **2012**, *14*, 1432.
7. *Org. Lett.*, **2012**, *14*, 170.

46-0323 **Methanesulfonato(2-di-*t*-butyl-phosphino-2',4',6'-tri-*i*-propyl-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [t-BuXPhos Palladacycle] [1447963-75-8]**
C₄₂H₅₈NO₃PPdS; FW: 794.38;
yellow powdr.

Note: Patents: PCT/US2013/030779,
US Serial No. 13/799620. Buchwald
Palladacycle Precatalyst Kit 2 component.
See (page 12).



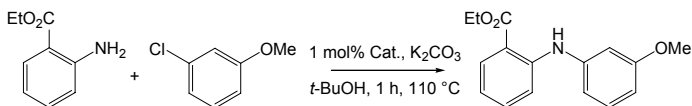
250mg
1g

PALLADIUM Compounds

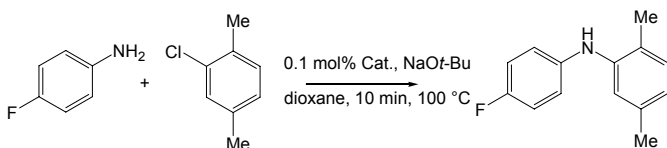
46-0323 **Methanesulfonato(2-di-*t*-butylphosphino-2',4',6'-tri-*i*-propyl-1,1'-biphenyl)**
(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [t-BuXPhos Palladacycle]
 (cont.) [1447963-75-8]

Technical Notes:

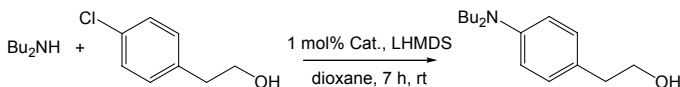
1. Palladium precatalyst for facile C-N cross-coupling reactions.
2. Palladium precatalyst for the arylation of *t*-butyl acetate.



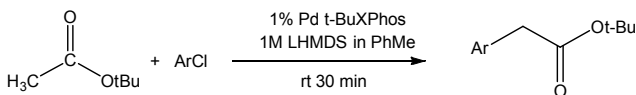
Tech. Note (1)
Ref. (1)



Tech. Note (1)
Ref. (1)



Tech. Note (1)
Ref. (1)



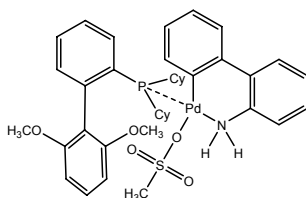
Tech. Note (2)
Ref. (2)

References:

1. *J. Am. Chem. Soc.*, **2008**, *130*, 6686.
2. *Chem. Sci.*, **2013**, *4*, 916.

46-0318 **Methanesulfonato(2-dicyclohexylphosphino-2',6'-dimethoxy-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II) dichloromethane adduct**, min. 98% [SPhos Palladacycle] [1445085-82-4]
 $C_{39}H_{48}NO_5PPdS$; FW: 780.26;
 white powder.

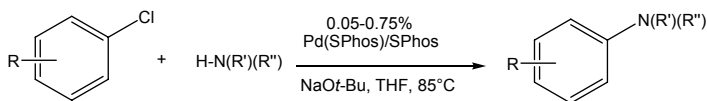
Note: Patents: PCT/US2013/030779,
 US Serial No. 13/799620. Buchwald Palladacycle Precatalyst Kit 2
 component. See (page 12).



250mg
1g
5g
25g

Technical Note:

1. Palladium precatalyst for the arylation of amines.



Tech. Note (1)
Ref. (1)

Reference:

1. *Chem. Sci.*, **2013**, *4*, 916.

PALLADIUM Compounds

46-0322

NEW→

Methanesulfonato(2-dicyclohexylphosphino-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl) palladium(II), min. 98% [BrettPhos Palladacycle]

[1470372-59-8]

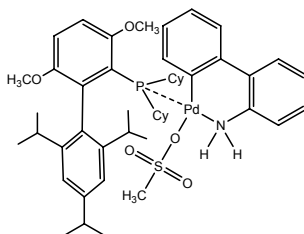
C₄₈H₆₆NO₅PPdS; FW: 906.50;

beige powdr.

Note: Patents: PCT/US2013/030779,

US Serial No. 13/799620. Buchwald Palladacycle

Precatalyst Kit 2 component. See (page 12).



100mg

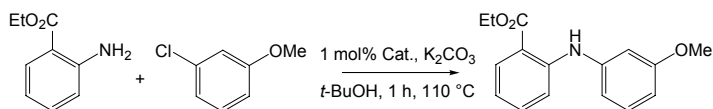
500mg

2g

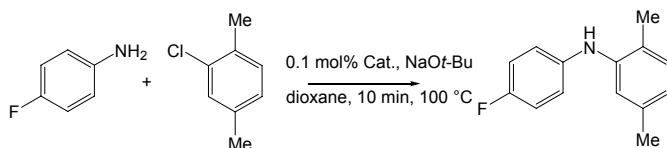
10g

Technical Notes:

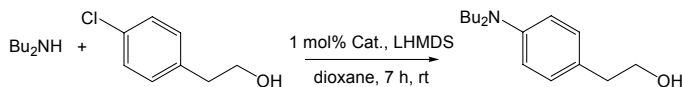
1. Palladium precatalyst for facile C-N cross-coupling reactions.
2. Palladium precatalyst for the arylation of primary amines.



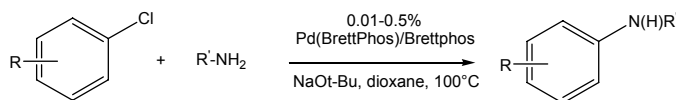
Tech. Note (1)
Ref. (1)



Tech. Note (1)
Ref. (1)



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

References:

1. *J. Am. Chem. Soc.*, **2008**, 130, 6686.
2. *Chem. Sci.*, **2013**, 4, 916.

46-0314

NEW→

Methanesulfonato(2-dicyclohexylphosphino-2',6'-di-*i*-propoxy-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [RuPhos Palladacycle] [1445085-77-7]

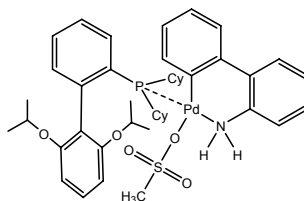
C₄₃H₅₆NO₅PPdS; FW: 836.37;

white powdr.

Note: Patents: PCT/US2013/030779,

US Serial No. 13/799620. Buchwald Palladacycle Precatalyst Kit 2

component. See (page 12).



250mg

1g

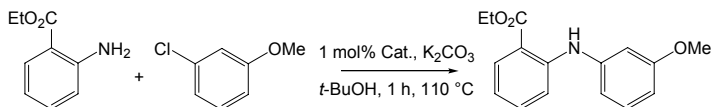
5g

Technical Notes:

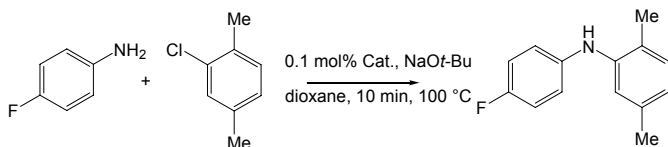
1. Palladium precatalyst for facile C-N cross-coupling reactions.
2. Palladium precatalyst for the arylation of secondary amines.

PALLADIUM Compounds

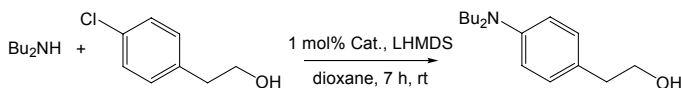
46-0314 Methanesulfonato(2-dicyclohexylphosphino-2',6'-di-*i*-propoxy-1,1'-biphenyl) (2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [RuPhos Palladacycle] [1445085-77-7]
NEW→
 (cont.)



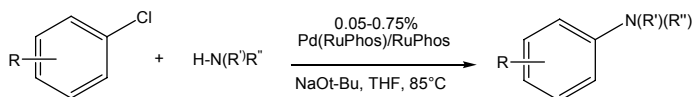
Tech. Note (1)
 Ref. (1)



Tech. Note (1)
 Ref. (1)



Tech. Note (1)
 Ref. (1)

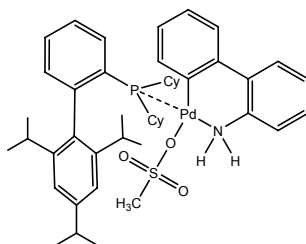


Tech. Note (2)
 Ref. (2)

References:

1. *J. Am. Chem. Soc.*, **2008**, *130*, 6686.
2. *Chem. Sci.*, **2013**, *4*, 916.

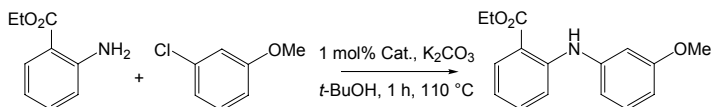
46-0320 Methanesulfonato(2-dicyclohexylphosphino-2',4',6'-tri-*i*-propyl-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98%
NEW→
 [XPhos Palladacycle] [1445085-55-1]
 $C_{46}H_{62}NO_3PPdS$; FW: 846.45;
 white powdr.
 Note: Patents: PCT/US2013/030779,
 US Serial No. 13/799620. Buchwald
 Palladacycle Precatalyst Kit 2 component.
 See (page 12).



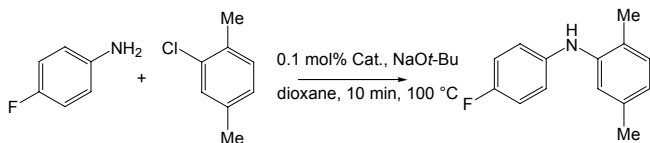
250mg
 1g
 5g

Technical Notes:

1. Palladium precatalyst for facile C-N cross-coupling reactions.
2. Palladium precatalyst for the arylation of primary amines.



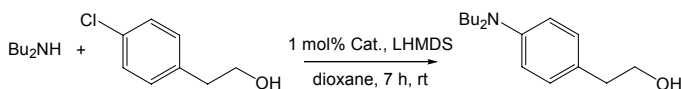
Tech. Note (1)
 Ref. (1)



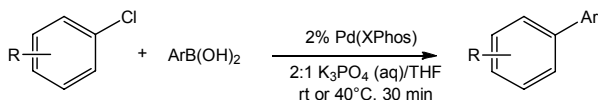
Tech. Note (1)
 Ref. (1)

PALLADIUM Compounds

46-0320 Methanesulfonato(2-dicyclohexylphosphino-2',4',6'-tri-*i*-propyl-1,1'-biphenyl) (2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [XPhos Palladacycle] [1445085-55-1]
NEW→
 (cont.)



Tech. Note (1)
 Ref. (1)

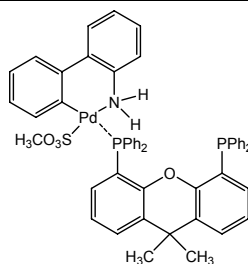


Tech. Note (2)
 Ref. (2)

References:

1. *J. Am. Chem. Soc.*, **2008**, 130, 6686.
2. *Chem. Sci.*, **2013**, 4, 916.

46-0957 Methanesulfonato[9,9-dimethyl-4,5-bis(diphenylphosphino)xanthene] [2'-amino-1,1'-biphenyl]palladium(II) dichloromethane adduct, min. 98% [1445085-97-1]
NEW→
 $C_{62}H_{45}NO_4P_2PdS$; FW: 948.35;
 pale yellow powdr.



500mg
 2g

Technical Note:

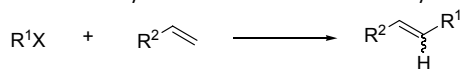
1. See 15-1242 (visit www.strem.com).

46-1781 Palladium(II) acetate, 99+% (99.95+%-Pd) [3375-31-3]
 $Pd_3(OOCCH_3)_6$; FW: 673.52; golden-brown xtl.

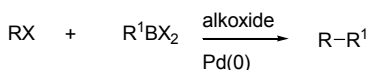
1g
 5g
 25g

Technical Notes:

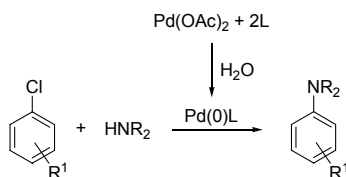
1. Efficient catalyst for the arylation of olefins (Heck reaction).
2. Catalyst for cross-coupling reactions.
3. Catalyst for C-H activation.
4. Precatalyst for enantioselective decarboxylative protonation of allyl β -ketoesters.



Tech. Note (1)
 Ref. (1)



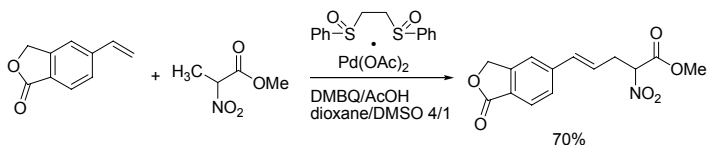
Tech. Note (2)
 Ref. (2,3)



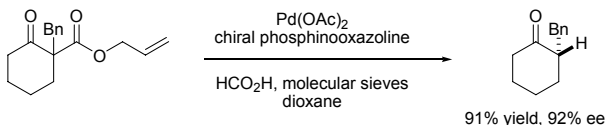
Tech. Note (2)
 Ref. (2,3)

PALLADIUM Compounds

46-1781 Palladium(II) acetate, 99+% (99.95+% Pd) [3375-31-3]
(cont.)



Tech. Note (2)
Ref. (2,3)

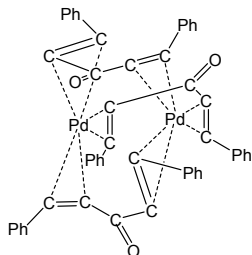


Tech. Note (4)
Ref. (10)

References:

1. *Angew. Chem. Int. Ed.*, **1994**, 33, 2379.
2. *Acta. Chem. Scand.*, **1993**, 47, 221.
3. *J. Org. Chem.*, **1994**, 59, 5034.
4. *Palladium Reagents in Organic Synthesis (R.F. Heck)*, **1985**, Chapter 6.
5. *Comprehensive Organic Synthesis*, **1991**, Vol. 3, Chapter 2.
6. *Encyclopedia of Reagents for Organic Synthesis*, **1995**, Vol. 6, 3847.
7. *Handbook of Organopalladium Chemistry for Organic Synthesis*, Negishi, E., Ed., Wiley-Interscience, New York, **2002**.
8. *Org. Lett.*, **2008**, 10, 3505.
9. *J. Am. Chem. Soc.*, **2008**, 130, 14090.
10. *J. Am. Chem. Soc.*, **2006**, 128, 11348.

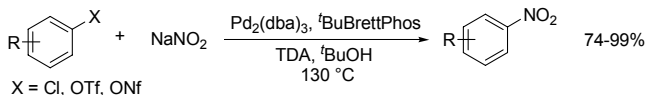
46-3000 Tris(dibenzylideneacetone)dipalladium(0)
[51364-51-3]
(C₆H₅CH=CHCOCH=CHC₆H₅)₃Pd₂;
FW: 915.70; purple pwdr.; m.p. 152-155°
air sensitive, moisture sensitive
Note: Palladium Kit component.
Visit www.strem.com.



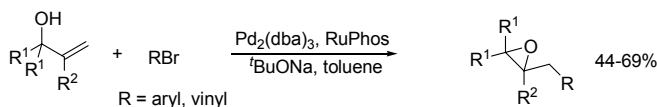
1g
5g
25g

Technical Notes:

1. Catalyst precursor for conversion of aryl chlorides, triflates, and nonaflates to nitroaromatics.
2. Catalyst for the synthesis of epoxides.
3. Catalytic asymmetric allylic and homoallylic diamination of terminal olefins.
4. Site-selective benzylic sp³ palladium-catalyzed direct arylation.
5. Palladium-catalyzed one-pot synthesis of tricyclic indolines.
6. Active catalyst for the Suzuki-Miyaura coupling of 2-pyridyl nucleophiles.
7. Catalyst in combination with BINAP for the asymmetric Heck Arylation of olefins.
8. Precursor for palladium-catalyzed carbon-nitrogen bond formation.
9. Catalyst for α-arylation of ketones,
10. Cross-coupling of aryl halides with aryl boronic acids.

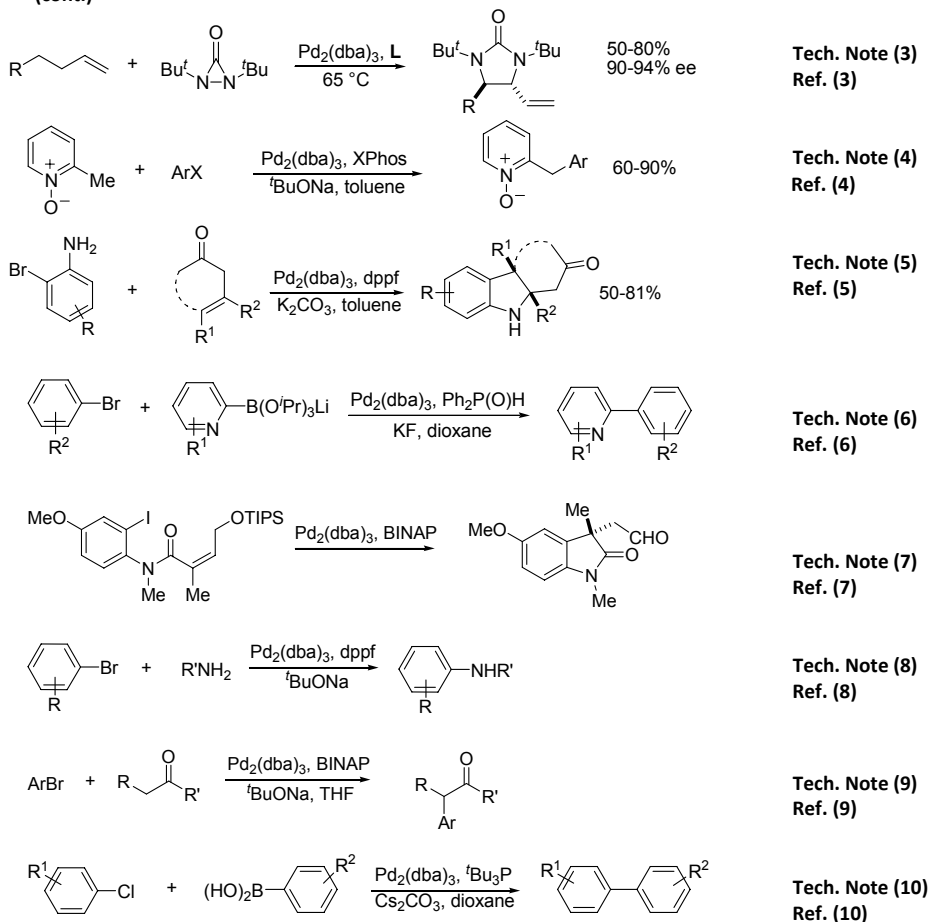


Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

PALLADIUM Compounds

46-3000 Tris(dibenzylideneacetone)dipalladium(0) [51364-51-3]
(cont.)


References:

1. *J. Am. Chem. Soc.*, **2009**, *131*, 12898.
2. *J. Am. Chem. Soc.*, **2009**, *131*, 2052.
3. *J. Am. Chem. Soc.*, **2008**, *130*, 8590.
4. *J. Am. Chem. Soc.*, **2008**, *130*, 3266.
5. *Angew. Chem. Int. Ed.*, **2008**, *47*, 177.
6. *Angew. Chem. Int. Ed.*, **2008**, *47*, 4695.
7. *J. Org. Chem.*, **1993**, *58*, 6949.
8. *J. Am. Chem. Soc.*, **1996**, *118*, 7217.
9. *J. Am. Chem. Soc.*, **1997**, *119*, 11108.
10. *Angew. Chem. Int. Ed.*, **1998**, *37*, 3387.
11. *Encyclopedia of Reagents for Organic Synthesis*, **1995**, Vol. 8, 5431.
12. *Comprehensive Organic Synthesis*, **1991**, Vol. 3, Chapter 2.
13. *Palladium Reagents in Organic Synthesis*, **1995**, Chapter 6.
14. *Handbook of Organopalladium Chemistry for Organic Synthesis*, 1st Ed., John Wiley & Sons, **2002**. (review)
15. *Coord. Chem. Rev.*, **1998**, *178*, 511.

PHOSPHORUS Compounds

15-1138

NEW→

2-(Di-1-adamantylphosphino)-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl, min. 95% AdBrettPhos
[1160861-59-5]

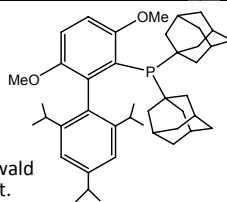
C₄₃H₅₁O₂P; FW: 640.92;

off-white to pale yellow powdr.

Note: Buchwald Biaryl Phosphine Ligand

Master Kit component. See (page 10). Buchwald Biaryl Phosphine Ligand Mini Kit 1 component.

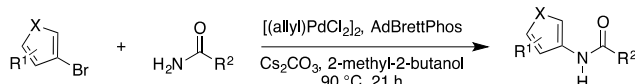
See (page 10). Patents: US 6,395,916, US 6,307,087.



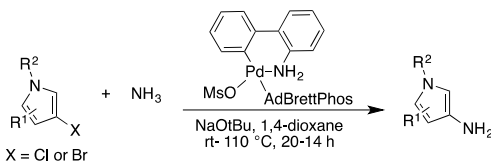
100mg
500mg
2g

Technical Notes:

1. Ligand used in the palladium-catalyzed amidation of five-membered heterocycles as electrophiles.
2. Ligand for the palladium-catalyzed monoarylation of ammonia.



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

References:

1. *J. Am. Chem. Soc.*, **2012**, 134, 19922.
2. *Org. Lett.*, **2013**, 15, 3734.

15-1164

NEW→

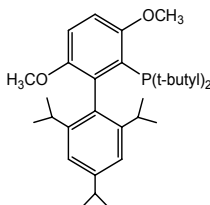
2-(Di-*t*-butylphosphino)-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl, min. 98% t-BuBrettPhos [1160861-53-9]

C₃₁H₄₉O₂P; FW: 484.69; white xtl.

Note: Buchwald Biaryl Phosphine Ligand

Master Kit component. See (page 10). Buchwald Biaryl Phosphine Ligand Mini Kit 1 component. See (page 10). Patents:

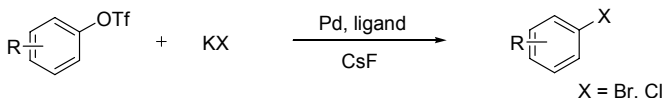
US 6,395,916, US 6,307,087.



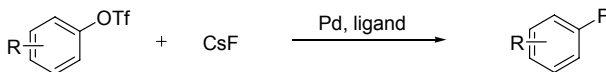
100mg
500mg

Technical Notes:

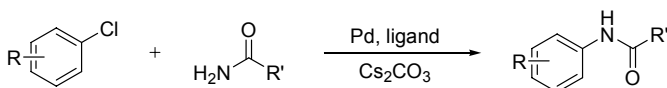
1. Ligand used in the Pd-catalyzed conversion of aryl and vinyl triflates to bromides, chlorides, and fluorides.
2. Ligand used in the Pd-catalyzed cross-coupling of amides and aryl mesylates.
3. Ligand used in the Pd-catalyzed O-arylation of ethyl acetohydroximates.
4. Ligand used in the Pd-catalyzed conversion of aryl chlorides, triflates, and nonaflates to nitroaromatics.
5. Ligand used in the arylation of ureas.



Tech. Note (1)
Ref. (1,2)



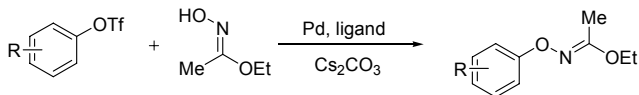
Tech. Note (1)
Ref. (3)



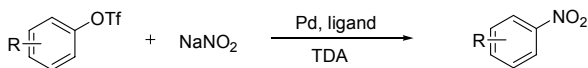
Tech. Note (2)
Ref. (4)

PHOSPHORUS Compounds

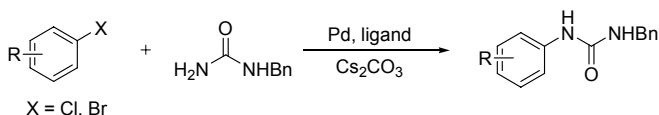
15-1164 **2-(Di-*t*-butylphosphino)-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl, min. 98%**
NEW→ ***t*-butylBrettPhos** [1160861-53-9]
 (cont.)



Tech. Note (3)
Ref. (5)



Tech. Note (4)
Ref. (6)

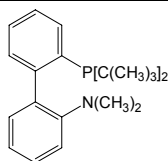


Tech. Note 5)
Ref. (7)

References:

1. *J. Am. Chem. Soc.*, **2010**, 132, 14076.
2. *Org. Lett.*, **2011**, 13, 4974.
3. *Science*, **2009**, 325, 1661.
4. *Org. Lett.*, **2010**, 12(10), 2350.
5. *J. Am. Chem. Soc.*, **2010**, 132, 9990.
6. *J. Am. Chem. Soc.*, **2009**, 131, 12898.
7. *Org. Lett.*, **2011**, 13, 3262.
8. *Chem. Sci.*, **2011**, 2, 27-50.

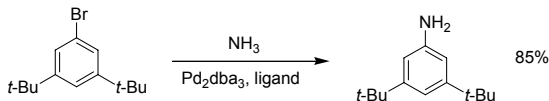
15-1048 **2-Di-*t*-butylphosphino-2'-(*N,N*-dimethyl-amino)biphenyl, 98%** [224311-49-3]
 (CH₃)₂NC₆H₄C₆H₄P(C₄H₉)₂; FW: 341.47;
 white xtl.
 Note: Buchwald Biaryl Phosphine Ligand
 Master Kit component. See (page 10).
 Buchwald Biaryl Phosphine Ligand Mini Kit 2
 component. See (page 10).
 Patents: US 6,395,916, US 6,307,087.



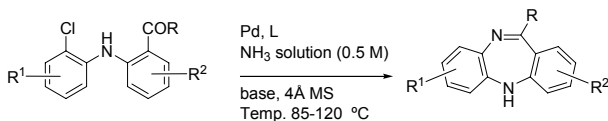
500mg
 2g
 10g

Technical Notes:

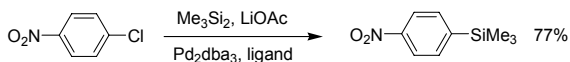
1. Useful ligand for Pd-catalyzed carbon-oxygen bond forming reactions.
2. Ligand used selective Pd-catalyzed arylation of ammonia. Application to the synthesis of dibenzodiazepines.
3. Ligand used for selective Pd-catalyzed silylation of aryl chlorides.



Tech. Note (2)
Ref. (2)



Tech. Note (2)
Ref. (3)



Tech. Note (3)
Ref. (4)

PHOSPHORUS Compounds

15-1048 2-Di-t-butylphosphino-2'-(N,N-dimethylamino)biphenyl, 98% [224311-49-3] (cont.)

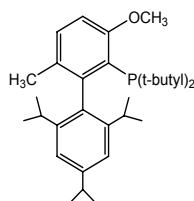
References:

1. *J. Am. Chem. Soc.*, **2001**, 123, 12202.
2. *J. Am. Chem. Soc.*, **2007**, 129, 10354.
3. *J. Am. Chem. Soc.*, **2011**, 133, 14228.
4. *Org. Lett.*, **2007**, 9, 3785.
5. *Chem. Sci.*, **2011**, 2, 27-50.

15-1168 2-(Di-t-butylphosphino)-3-methoxy-6-methyl-2',4',6'-tri-i-propyl-1,1'-biphenyl, min. 98% RockPhos [1262046-34-3]

NEW→

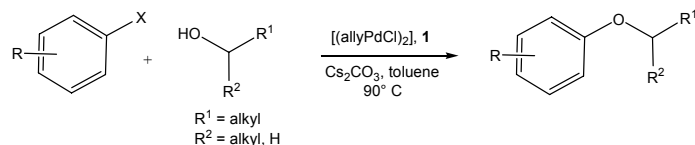
C₃₁H₄₉OP; FW: 468.69; white xtl.; m.p. 129-130°



100mg
500mg
2g

Technical Note:

1. Ligand used in palladium-catalyzed C-O bond forming reactions of secondary and primary alcohols with a range of aryl halides including heterocyclic partners. For the first time, electron-rich aryl halides can be coupled with secondary alcohols.



Reference:

1. *Angew. Chem. Int. Ed.*, **2011**, 50, 9943.

15-1052 2-Di-t-butylphosphino-2',4',6'-tri-i-propyl-1,1'-biphenyl, min. 98% t-butylXPhos [564483-19-8]

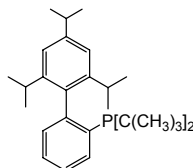
C₂₉H₄₅P; FW: 424.64; white xtl.; m.p. 147-149°

Note: Buchwald Biaryl Phosphine Ligand

Master Kit component. See (page 10). Buchwald

Biaryl Phosphine Ligand Mini Kit 1 component.

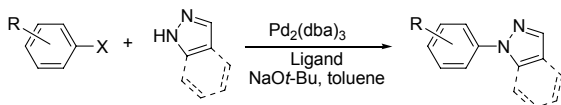
See (page 10). Patents: US 6,395,916, US 6,307,087.



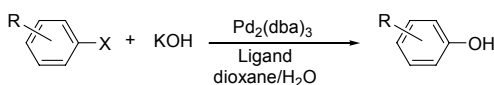
500mg
2g
10g
50g

Technical Notes:

1. Effective ligand for the Pd-catalyzed arylation of pyrazoles, indazoles and amino heterocycles.
2. Ligand used in the Pd-catalyzed synthesis of phenols from aryl halides and KOH.
3. Ligand used in the Pd-catalyzed of benzoic acids from aryl halides and CO₂.
4. Ligand used in the Pd-catalyzed trifluoromethylation of vinyl sulfonates.



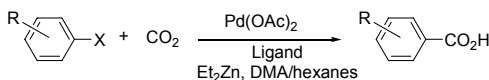
**Tech. Note (1)
Ref. (1)**



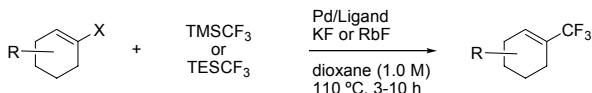
**Tech. Note (2)
Ref. (2)**

PHOSPHORUS Compounds

15-1052 2-Di-t-butylphosphino-2',4',6'-tri-i-propyl-1,1'-biphenyl, min. 98% t-butylXPhos (cont.) [564483-19-8]



Tech. Note (3)
Ref. (3)



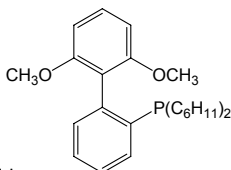
Tech. Note (4)
Ref. (4)

X = OTf or ONf

References:

1. *Angew. Chem., Int. Ed.*, **2006**, *45*, 6523.
2. *J. Am. Chem. Soc.*, **2006**, *128*, 10694.
3. *J. Am. Chem. Soc.*, **2009**, *131*, 15974.
4. *Org. Lett.*, **2011**, *13*, 6552.
5. *Chem. Sci.*, **2011**, *2*, 27-50.

15-1143 2-Dicyclohexylphosphino-2',6'-dimethoxy-1,1'-biphenyl, min. 98% SPhos [657408-07-6]
C₂₆H₃₅O₂P; FW: 410.53; white xtl.; m.p. 164-166°

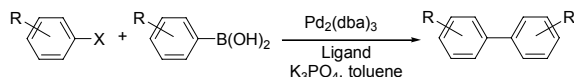


500mg
2g
10g
50g

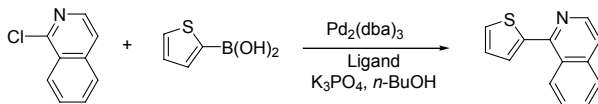
Note: Buchwald Biaryl Phosphine Ligand Master Kit component. See (page 10). Buchwald Biaryl Phosphine Ligand Mini Kit 1 component. See (page 10). Patents: US 6,395,916, US 6,307,087.

Technical Notes:

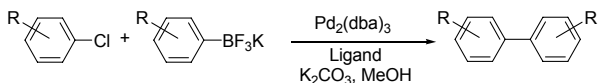
1. Generates highly active catalyst for Suzuki-Miyaura cross-coupling.
2. Ligand used in the Suzuki cross-coupling of heteroaryl substrates.
3. Ligand used in the Suzuki cross-coupling of aryl potassium trifluoroborates.
4. Effective ligand for the Pd-catalyzed borylation of aryl chlorides.
5. Ligand used in the Pd-catalyzed Kumada-Corriu reaction of functionalized aryl Grignard reagents at low temperature.
6. Allows for the coupling of amino acids derivatives without racemization.



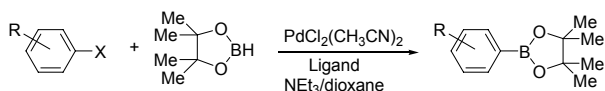
Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (3)



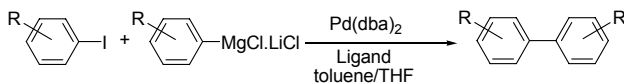
Tech. Note (3)
Ref. (4,5)



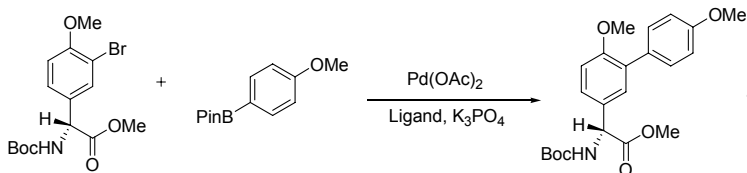
Tech. Note (4)
Ref. (6,7)

PHOSPHORUS Compounds

15-1143 2-Dicyclohexylphosphino-2',6'-dimethoxy-1,1'-biphenyl, min. 98% SPhos [657408-07-6]
(cont.)



Tech. Note (5)
Ref. (3)



Tech. Note (6)
Ref. (10)

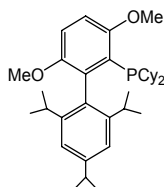
References:

1. *Angew. Chem., Int. Ed.*, **2004**, 43, 1871.
2. *J. Am. Chem. Soc.*, **2005**, 127, 4685.
3. *J. Am. Chem. Soc.*, **2007**, 129, 3358.
4. *Org. Lett.*, **2004**, 6, 2649.
5. *J. Org. Chem.*, **2009**, 74, 5446.
6. *Angew. Chem., Int. Ed.*, **2007**, 46, 5359.
7. *J. Org. Chem.*, **2008**, 73, 5589.
8. *J. Am. Chem. Soc.*, **2008**, 129, 3844.
9. *Acc. Chem. Res.*, **2008**, 41, 1461.
10. *J. Org. Chem.*, **2009**, 74, 9202.

15-1152 2-(Dicyclohexylphosphino)-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl, min. 98% BrettPhos [1070663-78-3]

C₃₅H₅₃O₂P; FW: 536.77; white xtl.;
m.p. 191-193°

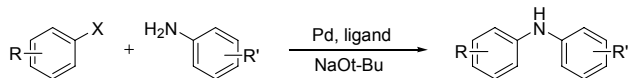
Note: Buchwald Biaryl Phosphine Ligand
Master Kit component. See (page 10). Buchwald
Biaryl Phosphine Ligand Mini Kit 1 component.
See (page 10). Patents: US 6,395,916, US 6,307,087.



250mg
1g
5g
25g

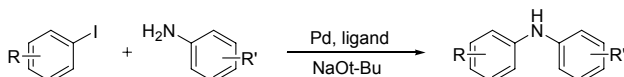
Technical Notes:

1. Versatile Ligand for the Pd-catalyzed coupling of primary arylamines and alkylamines.
 - a. See also 46-0367 (page 13), 46-0267 (page 14).
 - b. See reference 7,8.
2. Ligand for palladium-catalyzed cross-coupling reactions using aryl mesylates with electron-deficient anilines.
3. Ligand for palladium-catalyzed cross-coupling of primary arylamines at low catalyst loading.
4. Ligand for palladium-catalyzed cross-coupling of aryl iodides and primary amines.
5. Ligand for the Suzuki-Miyaura coupling of tosylates and mesylates.
6. Ligand for the palladium-catalyzed trifluoromethylation of aryl chlorides.
7. Ligand for the palladium-catalyzed formation of aryl-SCF₃ compounds from aryl bromides.
8. Ligand for the nickel-catalyzed cross-coupling of styrenyl epoxides with boronic acids.



X = Cl, OMs

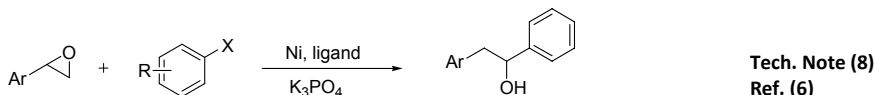
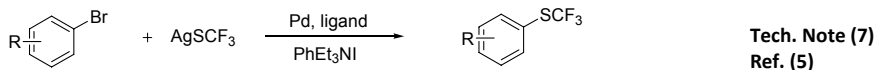
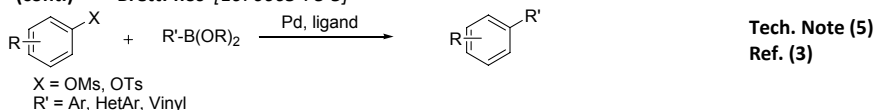
Tech. Note (2,3)
Ref. (1)



Tech. Note (4)
Ref. (2)

PHOSPHORUS Compounds

15-1152 (cont.) **2-(Dicyclohexylphosphino)-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl, min. 98% BrettPhos [1070663-78-3]**



References:

1. *J. Am. Chem. Soc.*, **2008**, *130*, 13552.
2. *J. Am. Chem. Soc.*, **2009**, *131*, 5766.
3. *Org. Lett.*, **2009**, *11*, 3954.
4. *Science*, **2010**, *328*, 1679.
5. *Angew. Chem, Int, Ed.*, **2011**, *50*, 7312.
6. *Angew. Chem. Int. Ed.*, **2011**, *50*, 6056.
7. *Chem. Sci.*, **2011**, *2*, 27-50.
8. *Chem. Sci.*, **2011**, *2*, 57-68.

15-1145 **2-(Dicyclohexylphosphino)-2'-(N,N-dimethylamino)biphenyl, 98% DavePhos [213697-53-1]**

(CH₃)₂NC₆H₄-C₆H₄P(C₆H₁₁)₂; FW: 393.55;

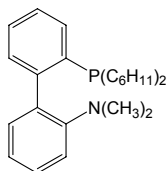
white xtl.; m.p. 115-119°

Note: Buchwald Biaryl Phosphine Ligand

Master Kit component. See (page 10).

Buchwald Biaryl Phosphine Ligand Mini Kit 2 component. See

(page 10). Patents: US 6,395,916, US 6,307,087.



500mg

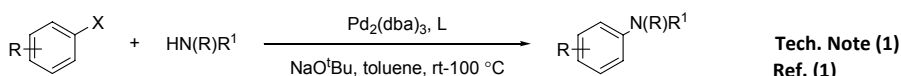
2g

10g

50g

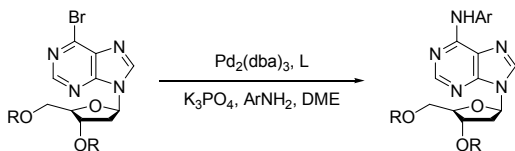
Technical Notes:

1. Ligand used in the Pd-catalyzed Suzuki coupling and activation of unactivated aryl chlorides. The reactions generally occur at room temperature and give high yields of product.
2. Ligand used in Pd-catalyzed C-N bond formation. A general synthesis of N6-aryl-2'-deoxyadenosine analogues.
3. Ligand used in Pd-catalyzed N-arylation of indoles.
4. Ligand used in Pd-catalyzed synthesis of aryl-tert-butyl ethers.
5. Effective ligand in the Pd-catalyzed arylation of ester enolates.
6. Ligand employed in arylation of ketone enolates using ortho-halo nitrobenzenes.
7. Ligand employed in the amination of aryl nonaflates using Pd catalysts.
8. Ligand used for cascade alkenyl amination/Heck reaction for the synthesis of indoles.
9. Ligand used in Pd-catalyzed Kumada-Corriu cross coupling at low temperatures.
10. Ligand used in Rh-catalyzed intramolecular hydroamination of unactivated terminal and internal alkenes with primary and secondary amines.
11. Ligand used in Au-catalyzed cycloisomerization of allenes.

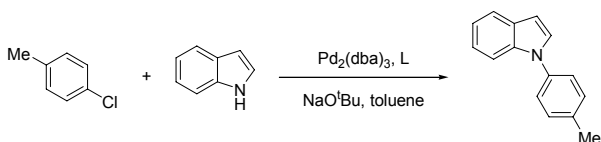


PHOSPHORUS Compounds

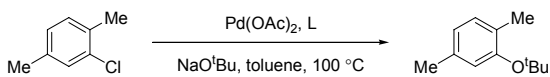
15-1145 2-(Dicyclohexylphosphino)-2'-(N,N-dimethylamino)biphenyl, 98% DavePhos [213697-53-1] (cont.)



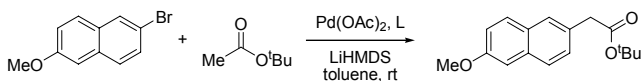
Tech. Note (2)
Ref. (2)



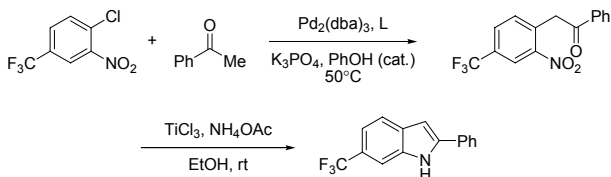
Tech. Note (3)
Ref. (3)



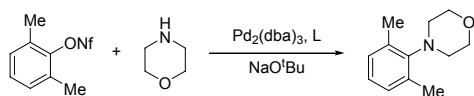
Tech. Note (4)
Ref. (4)



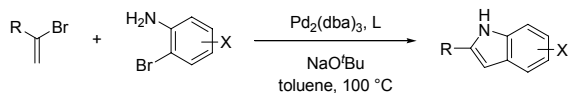
Tech. Note (5)
Ref. (5)



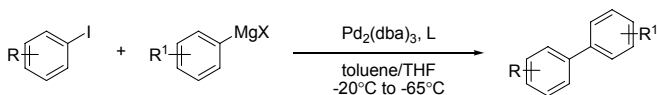
Tech. Note (6)
Ref. (6)



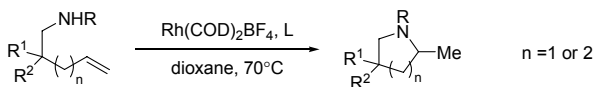
Tech. Note (7)
Ref. (7)



Tech. Note (8)
Ref. (8)



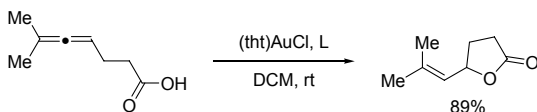
Tech. Note (9)
Ref. (9)



Tech. Note (10)
Ref. (10)

PHOSPHORUS Compounds

15-1145 2-(Dicyclohexylphosphino)-2'-(N,N-dimethylamino)biphenyl, 98% DavePhos [213697-53-1] (cont.)

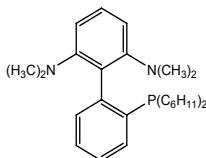


Tech. Note (11)
Ref. (11)

References:

1. *J. Am. Chem. Soc.*, **1998**, *120*, 9722.
2. *J. Am. Chem. Soc.*, **1999**, *121*, 6090.
3. *Org. Lett.*, **2000**, *2*, 1403.
4. *J. Org. Chem.*, **2001**, *66*, 2498.
5. *J. Am. Chem. Soc.*, **2001**, *123*, 7996.
6. *J. Am. Chem. Soc.*, **2002**, *124*, 15168.
7. *J. Org. Chem.*, **2003**, *68*, 9563.
8. *Chem. Eur. J.*, **2005**, *11*, 2276.
9. *J. Am. Chem. Soc.*, **2007**, *129*, 3844.
10. *J. Am. Chem. Soc.*, **2008**, *130*, 1570.
11. *Adv. Synth. Catal.*, **2009**, *351*, 576.
12. *Chem. Sci.*, **2011**, *2*, 27-50.

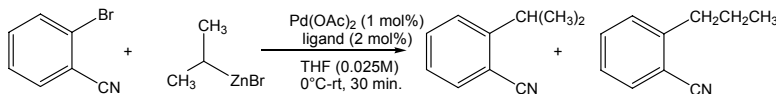
15-1147 2-Dicyclohexylphosphino-2',6'-dimethylamino-1,1'-biphenyl, min. 98% CPhos [1160556-64-8]
C₂₈H₄₁N₂P; FW: 436.61; yellow-orange xtl.; m.p. 111-113°
Note: Patents: US 6,395,916, US 6,307,087



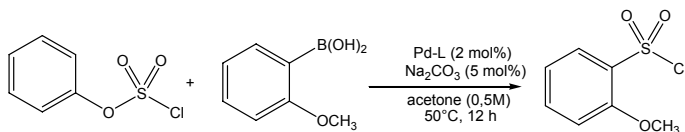
1g
5g

Technical Notes:

1. Liganad for the Negishi coupling of secondary alkylzinc halides with aryl bromides or chlorides.
2. Preparation of aryl sulfonamides via palladium-catalyzed chlorosulfonylation of arylboronic acids.



Tech. Note (1)
Ref. (1)

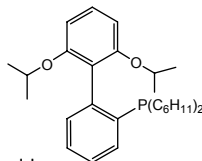


Tech. Note (2)
Ref. (2)

References:

1. *J. Am. Chem. Soc.*, **2009**, *131*, 7532.
2. *J. Am. Chem. Soc.*, **2013**, *135*, 10638.

15-1146 2-Dicyclohexylphosphino-2',6'-di-i-propoxy-1,1'-biphenyl, min. 98% RuPhos [787618-22-8]
C₃₀H₄₃O₂P; FW: 466.64; white powdr.; m.p. 123-124°
Note: Buchwald Biaryl Phosphine Ligand Master Kit component. See (page 10). Buchwald Biaryl Phosphine Ligand Mini Kit 1 component. See (page 10).
Patents: US 6,395,916, US 6,307,087.



1g
5g
25g
100g

Technical Notes:

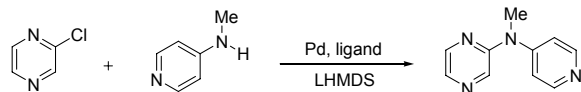
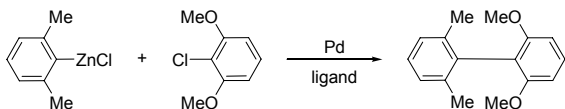
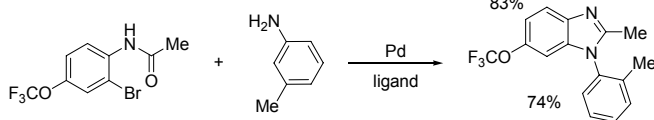
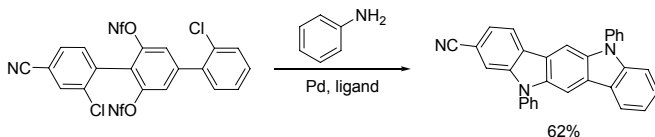
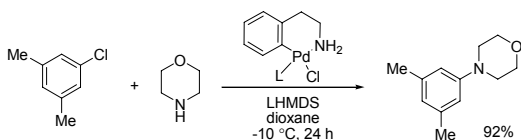
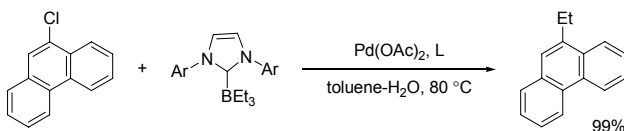
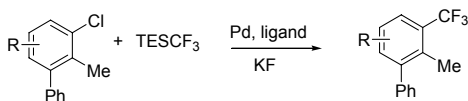
1. Versatile Ligand for the Pd-catalyzed coupling of secondary arylamines and alkylamines. See also 46-0266 (visit www.strem.com), 46-0366 (page 13). See reference 7, 8.
2. Ligand used for the Pd-catalyzed Negishi cross-coupling reaction of (hetero)arylchlorides.
3. Ligand used for the Pd-catalyzed synthesis of N-aryl benzimidazoles.

PHOSPHORUS Compounds

15-1146 2-Dicyclohexylphosphino-2',6'-di-i-propoxy-1,1'-biphenyl, min. 98% RuPhos (cont.) [787618-22-8]

Technical Notes (cont.):

- Ligand used for the Pd-catalyzed synthesis of heteroarenes.
- Versatile ligand used for the Pd-catalyzed C-N coupling reaction of secondary aryl- and alkyl-amines at low temperature with the Pd precatalyst.
- Ligand used for the Pd-catalyzed Suzuki-Miyaura coupling of aryl chloride and NHC-boranes.
- Ligand for the palladium-catalyzed trifluoromethylation of hindered aryl chlorides.


 Tech. Note (1)
Ref. (6,7)

 Tech. Note (2)
Ref. (1)

 Tech. Note (3)
Ref. (2)

 Tech. Note (4)
Ref. (3)

 Tech. Note (5)
Ref. (4)

 Tech. Note (6)
Ref. (5)

 Tech. Note (7)
Ref. (6)

References:

- J. Am. Chem. Soc.*, **2004**, 126, 13028.
- Angew. Chem. Int. Ed.*, **2007**, 46, 7509.
- J. Org. Chem.*, **2007**, 72, 5119.
- J. Am. Chem. Soc.*, **2008**, 130, 6686.
- Org. Lett.*, **2009**, 11, 4914.
- Science*, **2010**, 328, 1679.
- Chem. Sci.*, **2011**, 2, 27-50.
- Chem. Sci.*, **2011**, 2, 57-68.

PHOSPHORUS Compounds

15-1149 2-(Dicyclohexylphosphino)-2',4',6'-tri-*i*-propyl-1,1'-biphenyl, min. 98% XPhos [564483-18-7]

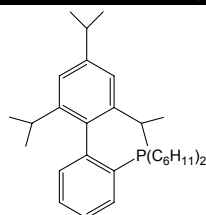
 C₃₃H₄₉P; FW: 476.72; white powd.; m.p. 185°

Note: Buchwald Biaryl Phosphine Ligand

Master Kit component. See (page 10).

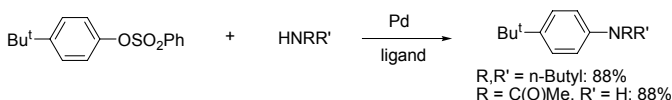
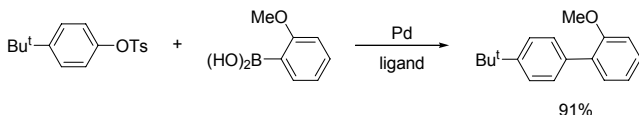
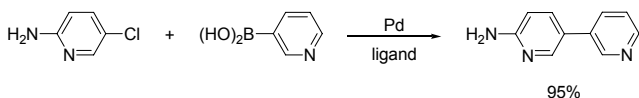
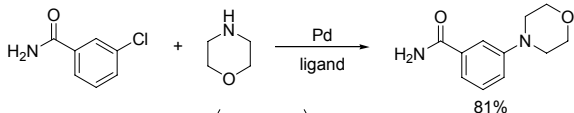
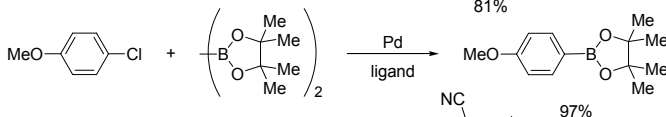
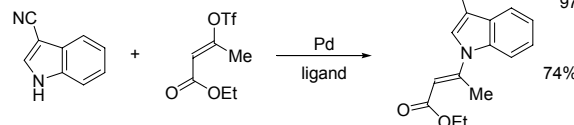
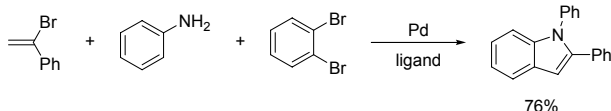
Buchwald Biaryl Phosphine Ligand Mini Kit 1 component. See (page 10). Patents:

US 6,395,916, US 6,307,087.


 500mg
2g
10g
100g
500g

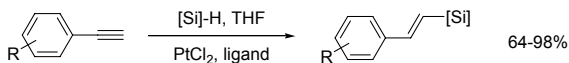
Technical Notes:

1. See also 46-0264 (visit www.strem.com).
2. Exceptional ligands for Pd-catalyzed amination and amidation of aryl sulfonates. (see Ref. 16).
3. Ligand used for the Pd-catalyzed Suzuki-Miyaura coupling reaction and carbonyl enolate coupling (see Ref. 9).
4. Ligand used for the chemoselective amination of aryl chlorides.
5. Ligand used for the Pd-catalyzed borylation of aryl chlorides.
 - a. For the formation of trifluoroborates, see also Ref. 11.
6. Ligand used for the Pd-catalyzed amination of vinyl halides and triflates.
7. Ligand used for the Pd-catalyzed three-component synthesis of indoles.
8. Ligand used for the Pt-catalyzed regioselective hydrosilylation of functionalized terminal arylalkynes.
9. Ligand used for the Pd-catalyzed synthesis of carbazoles.
10. Ligand used for the Pd-catalyzed Suzuki-Miyaura coupling of aryl chloride and NHC-boranes.
11. Ligand used for the direct arylation of picoline *N*-oxide.
12. Ligand used for the Negishi coupling of 2-heterocyclic organozinc reagents.
13. Catalyst for a phosphine-catalyzed Heine reaction.
14. Ligand used for the palladium-catalyzed oxidative coupling of indoles and heteroarenes.

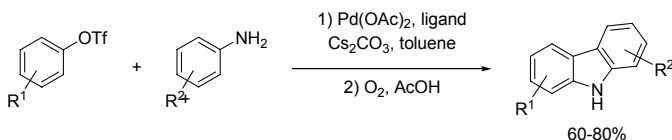

 Tech. Note (2)
Ref. (1)

 Tech. Note (3)
Ref. (2)

 Tech. Note (3)
Ref. (3,4)

 Tech. Note (4)
Ref. (3)

 Tech. Note (5)
Ref. (5)

 Tech. Note (6)
Ref. (6)

 Tech. Note (6)
Ref. (7)

PHOSPHORUS Compounds

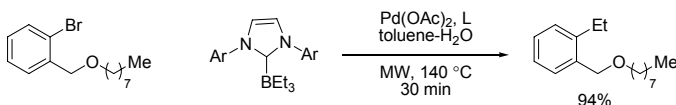
15-1149 2-(Dicyclohexylphosphino)-2',4',6'-tri-*i*-propyl-1,1'-biphenyl, min. 98% XPhos
(cont.) [564483-18-7]



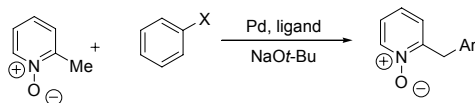
Tech. Note (7)
Ref. (8)



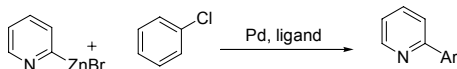
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Ref. (10)



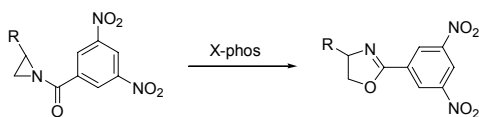
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Ref. (10)



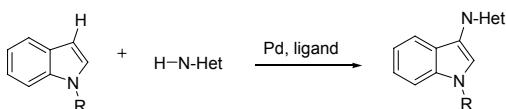
Tech. Note (11)
Ref. (12)



Tech. Note (12)
Ref. (13)



Tech. Note (13)
Ref. (14)



Tech. Note (14)
Ref. (15)

References:

1. *J. Am. Chem. Soc.*, **2003**, 125, 6653.
2. *J. Am. Chem. Soc.*, **2003**, 125, 11818.
3. *Angew. Chem. Int. Ed.*, **2006**, 45, 6523.
4. *J. Am. Chem. Soc.*, **2007**, 129, 3358.
5. *Angew. Chem. Int. Ed.*, **2007**, 46, 5359.
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7. *Angew. Chem. Int. Ed.*, **2007**, 46, 1529.
8. *Tetrahedron Lett.*, **2008**, 49, 2429.
9. *Acc. Chem. Res.*, **2008**, 41, 1461.
10. *J. Org. Chem.*, **2009**, 74, 4720.
11. *Org. Lett.*, **2009**, 11, 4914.
12. *J. Am. Chem. Soc.*, **2010**, 132, 17701.
13. *J. Org. Chem.*, **2010**, 75, 8330.
14. *Org. Lett.*, **2011**, 13, 5444.
15. *Angew. Chem., Int. Ed.*, **2011**, 50, 5365.
16. *Chem. Sci.*, **2011**, 2, 27-50.

15-6700 Triphenylphosphine, 99% [603-35-0]

(C₆H₅)₃P; FW: 262.28; white xtl.; m.p. 79°; b.p. 360°; f.p. 359°F

100g

500g

2kg

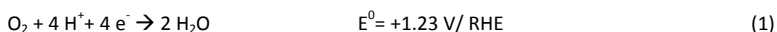
Dealloyed Pt core-shell nanoparticles: Active and durable electrocatalysts for low-temperature Polymer Electrolyte Membrane Fuel Cells (PEMFCs)

Professor Dr. Peter Strasser

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Department of Chemistry, Chemical Engineering Division,
Technical University Berlin, Germany
pstrasser@tu-berlin.de*

Polymer electrolyte membrane fuel cells (PEMFCs) represent an important emerging power generation technology for stationary as well as medium and long range transportation applications. This is because PEMFCs show favorable gravimetric power densities, while the fuels they run on typically exhibit high gravimetric energy densities (1-5) compared to state-of-art metal ion batteries. However, wider use of PEMFC technology is hampered by performance, cost, and durability issues associated with materials and components. Figure 1 displays a cross section of the layered structure of a low temperature PEMFC showing the anode (left) and cathode (right) gas diffusion layers (GDLs), which sandwich the anode and cathode catalyst layers and the proton exchange membrane. Figure 1 also schematically shows the molecular as well as electrical pathways of hydrogen fuel molecules, oxygen molecules, protons as well as of electrons. The overall performance of a PEMFC in terms of its practical cell voltage is limited by kinetic, ohmic, and mass transport processes for low, medium and high current densities, respectively. Of these, the kinetic surface catalytic reactions cause the most severe fuel cell voltage losses.

The electrocatalytic Oxygen Reduction Reaction (ORR) at the cathode according to



represents a key challenge in PEMFC technology (5-7). In acidic media, Pt catalysts supported on high surface area carbons are the ORR catalysts of choice (8, 9). Dating back to catalysis research for Phosphoric acid fuel cells (PAFCs), many experimental ORR catalysis studies during the 1990s focused on Pt-rich bimetallic alloys which typically exhibited a modest intrinsic activity improvement of a factor of 2-3x at 900 mV cell voltage compared to pure Pt (10-17).

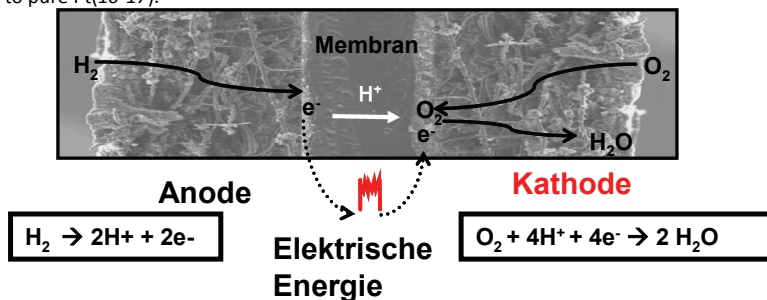


Figure 1: Cross sectional electron micrograph of a single PEMFC membrane electrode assembly. Chemical catalytic reaction and transport processes are indicated.

At the beginning of this millennium, consensus was reached that virtually all metal alloy ORR catalysts leach their non-noble metal component to some degree. This implies that ORR catalyst form a core-shell structure under operando conditions of a fuel cell. So, in subsequent years focus shifted toward core-shell ORR catalyst concepts. Such structures show a two-fold advantage. First, the expensive noble metal is enriched in the shell, while nearly absent in the particle core; this helps minimize the noble metal content for a given catalyst surface area. Second, the nature and composition of the particle core controls the surface catalytic behavior of the active noble metal in the shell through electronic and geometric effects. This can significantly increase the intrinsic surface-area normalized catalyst activity. Taken together, owing to their core-shell structure, technologically relevant and economically viable fuel cell catalyst performances have been realized over the past years.

This article addresses dealloyed Pt core-shell fuel cell electrocatalysts (18-39). Dealloying is the selective removal of a less noble component from the surface of a bimetallic alloy (40-42); dealloying of macroscopic alloys has been studied in the corrosion science community for several decades. Exploring the atomic processes of dealloying of nanoscale alloys, however, is poorly understood and has become a research area of much interest. Owing to their compositional and geometric structure, dealloyed Pt alloy particle catalysts are active materials for the oxygen electroreduction at the fuel cell cathode, exhibiting a multi-fold increase in the Pt mass based ORR activity as well as their surface-area normalized activity. Also, dealloyed core shell nanocatalysts lend themselves well for use in carbon-supported high-surface area catalyst formats as used in Membrane Electrode Assemblies (MEAs) of Polymer Electrolyte fuel cells (PEMFCs).

The concept of dealloyed Pt core-shell nanocatalysts

Figure 2 illustrates a dealloying process of a precursor particle that results in a Pt core-shell nanoparticle. A bimetallic alloy precursor consisting of a more noble and a less noble component is enriched in the less noble component and undergoes a chemical or electrochemical leaching, which selectively removes the less noble metal from the surface of the alloy nanoparticle. The more noble component remains at the surface of the particle in a highly under-coordinated state and diffuses along the surface until it binds to a step or kink site. This interplay of dissolution and surface diffusion eventually forms a dealloyed core-shell particle with a Pt-enriched surface region (particle shell).

The thickness of the Pt enriched shell of the dealloyed particles can be controlled by choice of dealloying conditions such as dealloying potential, acid type and concentration, or leaching time. Studies have revealed that all these parameters affect the rate of leaching and the rate of Pt surface diffusion, which are the underlying controlling parameters in the dealloying process. Dealloyed particle shells typically consist of multiple Pt layers. Aside from dealloying process parameters, the initial particle size and composition affect the rate of dissolution and Pt surface diffusion, as well, and, as such, control the emerging morphology of the resulting dealloyed particles.

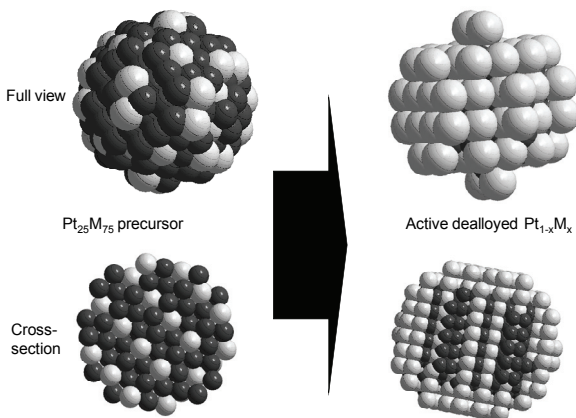


Figure 2: The notion of dealloyed Pt core-shell nanoparticles: an alloy particle precursor is chemically leached or electrochemically dealloyed. As the less noble alloy component selective leaches out, a Pt shell remains surrounding a Pt alloy core. Reproduced from ref.(30)

Synthesis and characterization of alloy catalyst precursors

Dealloyed Pt ORR electrocatalysts are prepared from bimetallic Pt-M alloy precursors consisting of Pt and a less noble metal 'M'. The alloy precursor is generally designed to be enriched in the less noble component to ensure ready bulk dealloying, that is, it exhibits stoichiometries of Pt_xM_{1-x} with $x=0.1 - 0.5$. Preferably, the less noble metal M is miscible with Pt. Copper and other face center cubic metals fulfill this condition well.

The synthesis of M rich precursor materials may involve stepwise impregnation of aqueous salt solutions of Pt and M onto weighted amounts of highly dispersed carbon supports. The impregnation is followed by freeze drying, chemical reduction, and thermal alloying of the carbon/ Pt / M composite. Surfactants, organic capping ligands, or even polymers have been used to improve the dispersion of the catalyst precursors, yet the complete removal of the surfactant/polymer has remained a challenge.

Figure 3 shows examples of typical X-ray diffraction profiles of $\text{Pt}_{25}\text{M}_{75}$ (here $\text{M}=\text{Cu}$) precursors thermally reduced and annealed at 600 °C, 800 °C, and 950 °C. The overall peak profiles suggest the formation of disordered face centered cubic (fcc) alloys. The peak pattern further suggests that annealing at 600 °C and 800 °C was insufficient to form perfectly homogeneous Pt-Cu alloys phases: sharp reflections consistent with a pure Cu phase with large crystallite size (in special cases related to the mean particle size) remain visible in the XRD profile. The alloy uniformity improves for increasing annealing temperatures; while this is typically desirable, the crystallite size also increases.

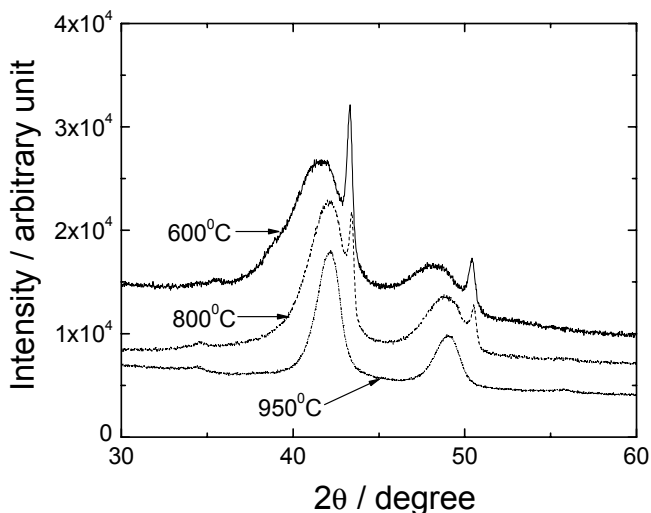


Figure 3: X-ray diffraction profiles of Pt-Cu alloy nanoparticle precursors, prepared at three different temperatures. Reproduced from ref.(30)

Catalyst activation and oxygen reduction reaction (ORR) activity

The selective dissolution of the less noble alloy component is a key process in the formation of the active core-shell catalyst. Figure 4 reports the cyclic voltammograms (CVs) during the initial stage of the dealloying process for three PtCo_3 and one PtCu_3 precursor. The first voltammetric dealloying cycle of both the Pt-Co and the Pt-Cu materials exhibited broad and intense Co and Cu dissolution peaks. On the cathodic scans, first, surface Pt oxides are reduced to metallic Pt followed by sharp anodic feature commensurate with renewed dissolution of Co (slightly positive current waves in Figure 4a-c) and, in case of the Pt-Cu materials in a stagnant electrolyte, by the deposition of Cu (Figure 4d). During subsequent voltammetric dealloying cycles, the voltammetric profile gradually approaches that of a pure Pt surface in accordance with the notion of the formation of a Pt particle shell. During the dealloying process the material loses significant amounts of Co and Cu and, depending on initial alloy composition and the dealloying conditions (upper turning potential, potential scan rate, acid conditions, temperature etc), may reach final compositions of the core-shell structures of up to $\text{Pt}_{80}\text{M}_{20}$ ($\text{M} = \text{Cu}$ or Co).

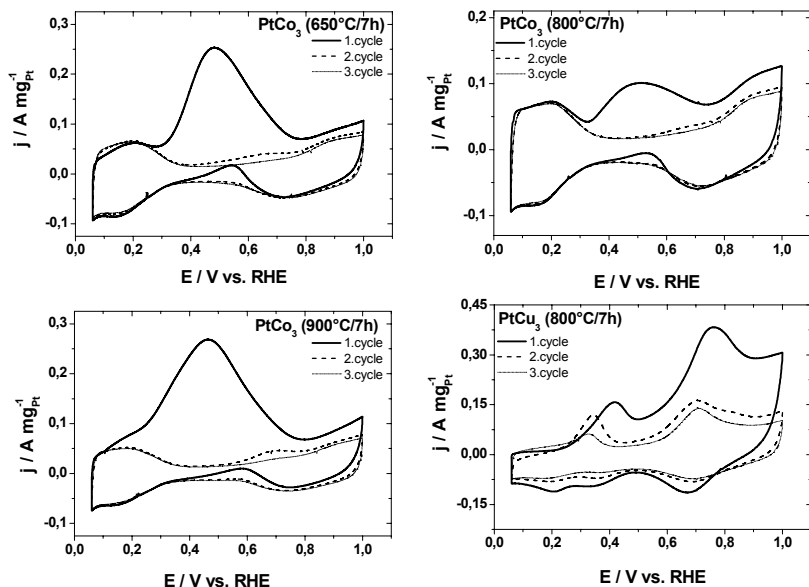


Figure 4: Initial CV profiles of three different PtCo_3 precursor alloy nanoparticles, and one PtCu_3 . Annealing conditions for each material is indicated. Conditions: 100 mV s^{-1} , 0.1 M HClO_4 . Reproduced from ref.(25)

The electrocatalytic oxygen reduction reaction (ORR) activity of dealloyed core shell Pt-Cu catalyst was measured by sweep voltammetry in O_2 saturated HClO_4 electrolyte using a Rotating Disk Electrode (Figures 5 and 6). The inset presents the time-stable voltammogram of the dealloyed core-shell catalysts after dealloying and before catalytic activity testing. The steep portion of the ORR voltammetric activity profiles are shifted to more positive electrode potentials indicating increased catalytic ORR activity compared to pure Pt. Figure 6 provides a direct comparison of the Pt-mass based activity (units A/mg_{Pt}), the Pt surface-area based activity, also referred to as specific activity (units in $\mu\text{A}/\text{cm}^2_{\text{Pt}}$), and the electrochemical surface area A (units m^2/g) for the de-alloyed Pt-Cu catalysts compared to a Pt electrocatalyst. At an electrode potential of 0.9 V , the dealloyed $\text{Pt}_{25}\text{Cu}_{75}$ nanoparticle catalysts, in particular the one annealed at 800°C outperformed pure Pt particle catalysts by a factor of 4-6x. Notably, the electrochemical active surface areas of the three dealloyed catalysts show no increase compared to pure Pt ruling out pure surface area enhancement effects.

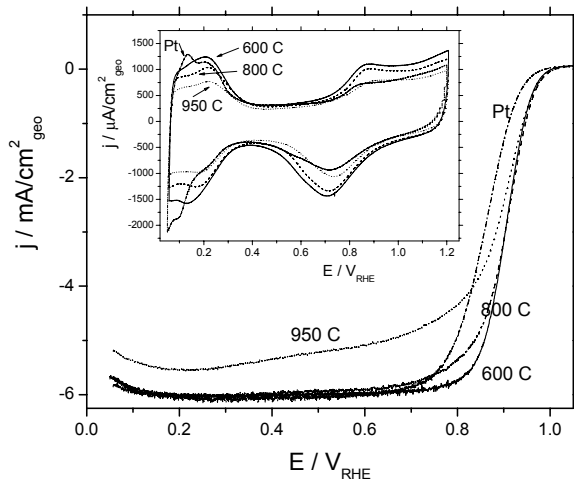


Figure 5: Oxygen reduction linear sweep voltammetry of dealloyed Pt-Cu core shell catalysts compared to a state-of-art Pt catalyst. Reproduced from ref.(30)

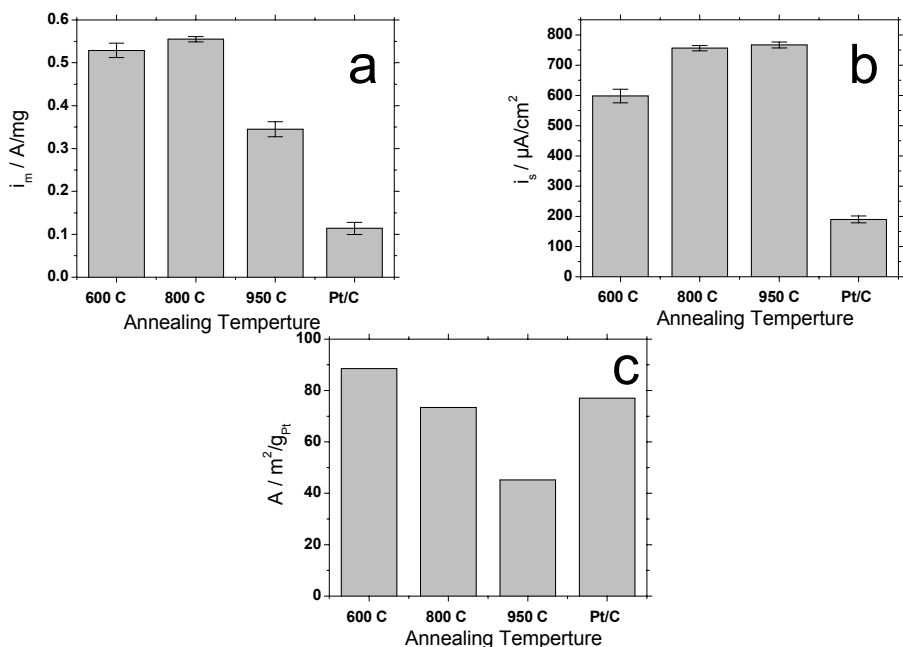


Figure 6: Comparison of (a) Pt mass based oxygen reduction reaction (ORR) activity (i_m), (b) specific ORR activity (i_s), and (c) the electrochemical surface area of three dealloyed Pt-Cu core-shell catalysts (see Fig 3 and 5) and a Pt catalyst. Reproduced from ref.(30)

Similar voltammetric ORR activity profiles and catalytic activity values were measured for dealloyed PtCo_3 core shell catalysts, see Figure 7 and Table 1.

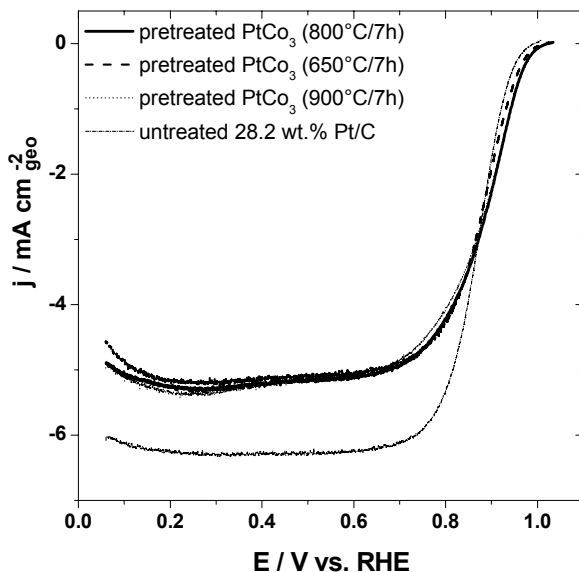


Figure 7: ORR linear sweep voltammetry of dealloyed ("pretreated") PtCo_3 and a PtCu_3 catalyst. Reproduced from ref. (30)

catalyst	chemical composition nominal via EDS	chemical composition final via EDS	electro chemical surface area (ECSA)	specific current density at 0.90 V/RHE	Pt mass based current density at 0.90 V/RHE
	(at. %)	(at. %)	(m ² g _{Pt} ⁻¹)	(μA cm _{Pt} ⁻²)	(A mg _{Pt} ⁻¹)
PtCo ₃ (650°C/7h)	Pt ₂₆ Co ₇₂	Pt ₈₂ Co ₁₈	40 ± 4	701 ± 68	0.28 ± 0.05
PtCo ₃ (800°C/7h)	Pt ₃₇ Co ₆₃	Pt ₈₀ Co ₂₀	45 ± 4	804 ± 146	0.38 ± 0.05
PtCo ₃ (900°C/7h)	Pt ₂₇ Co ₇₃	Pt ₇₃ Co ₂₇	36 ± 2	811 ± 99	0.29 ± 0.04
Pt/HSAC	Pt ₁₀₀	Pt ₁₀₀	73 ± 3	179 ± 4	0.13 ± 0.01

Table 1: Chemical compositions before (“nominal”) and after (“final”) voltammetric dealloying and ORR activity testing, catalytic Pt mass and specific ORR activities of dealloyed PtCo₃, PtCu₃ core shell catalysts and a Pt catalyst from Figure 7. Reproduced from ref. (30)

Of great concern for membrane and fuel cell durability is the formation of hydrogen peroxide (H₂O₂) and OH radicals at the cathode catalyst. These species are known to have the capability to rapidly degrade the polymer membrane through an “unzipping mechanism” resulting in pinholes, gas cross over and severe cell failures. The H₂O₂ selectivities of the dealloyed Pt-Cu and Pt-Co cathode catalysts are shown in Figure 8. The measurements confirmed that the H₂O₂ production is quite favorable and largely comparable to pure Pt catalysts in the typically electrode potential ranges of a fuel cell cathode (0.5 – 1.0 V). As expected, pure carbon support materials form quite significant amounts of H₂O₂.

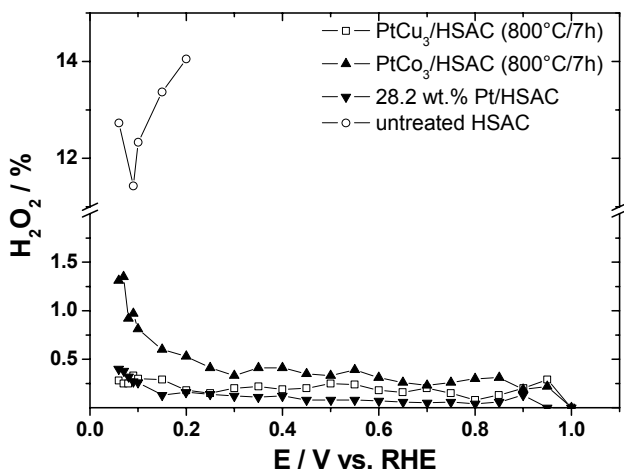


Figure 8: Hydrogen peroxide production versus electrode potential during the O₂ reduction for dealloyed PtCo₃, PtCu₃, pure Pt, and a pure carbon electrocatalysts. Reproduced from ref. (30)

Membrane Electrode Assembly (MEA) implementation and single cell performance

The practical usefulness of a novel ORR electrocatalyst critically depends on the feasibility to incorporate it in Membrane Electrode Assemblies (MEAs) and eventually fuel cell stacks for performance and durability studies(26, 36, 38, 43, 44). To demonstrate this, a number of different bimetallic and trimetallic dealloyed Pt alloy nanoparticle catalysts were prepared, incorporated in MEAs, tested and compared against a state-of-the-art pure Pt catalysts. Figure 9 displays the measured polarization curves of dealloyed bimetallic Pt-Cu, Pt-Co,

and Pt-Ni core shell catalysts compared to a state-of-art carbon-supported 45 wt% Pt catalyst. It is evident that MEAs with dealloyed Pt cathodes show comparable or improved current densities over a broad current density range despite their drastically reduced geometric Pt loadings (0.1-0.17 mg_{Pt}/cm² for alloys compared to 0.3 mg_{Pt}/cm² for Pt). In particular, Figure 9a shows that the dealloyed catalysts do not cause detrimental effects in the ohmic and mass transport region of the polarization curve. To contrast the kinetic activity of dealloyed Pt catalysts against that of commercial pure Pt cathode catalysts, the kinetic current density of the single cell measurements of Figure 9a was normalized with respect to the Pt loading of the ORR electrode, yielding Tafel lines as shown in Figure 9b. The dealloyed Pt catalysts clearly outperform the Pt standard catalyst by a factor 3x – 4x in the kinetic regime, suggesting lower activation barriers presumably associated with more favorable chemisorption energies of reaction intermediates.

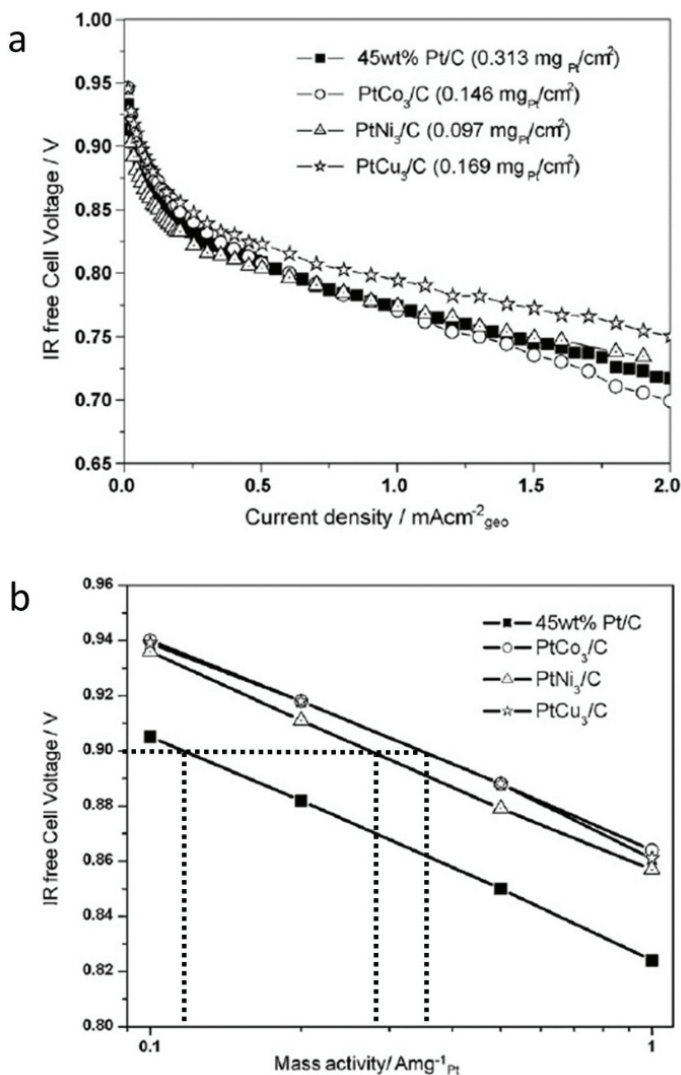


Figure 9: (a) Current-voltage characteristics of 10 cm² single H₂/O₂ fuel cells using dealloyed PtCu₃, dealloyed PtNi₃ and dealloyed PtCo₃ cathode catalyst, in comparison with standard Pt cathode catalysts. (b) Tafel plot of Pt-mass activities at 0.9V of the dealloyed Pt-bimetallic cathode catalysts compared to the Pt catalyst. Reproduced from ref. (26)

The precise origin of the high activity of the alloy catalysts in these realistic environments, however, is not fully resolved. It is likely that electronic and geometric enhancement effects, studied and proved in well-defined model catalyst formats, play a major role. Under the current conditions, dealloyed PtCo_3 and PtCu_3 appear somewhat more active than dealloyed PtNi_3 . Detailed compositional and performance data of the three dealloyed cathode catalysts are provided in Table 2.

Nominal composition	EDS composition (as prepared) [at %]	XPS composition (as prepared) [at %]	ICP composition (after dealloying) [at %]	XPS composition (after dealloying) [at %]	ECSA _{Pt} [m ² /g _{Pt}]	Mass activity @ 0.9V [A/mg _{Pt}]	Specific activity @ 0.9V [μA/cm ² _{Pt}]
Pt	-	-	-	-	63	0.104	166
Pt ₂₅ Co ₇₅	Pt ₂₆ Co ₇₄	Pt ₄₂ Co ₅₈	Pt ₈₃ Co ₁₇	Pt ₈₆ Co ₁₄	70	0.346	491
Pt ₂₅ Ni ₇₅	Pt ₁₈ Ni ₈₂	Pt ₃₈ Ni ₆₂	Pt ₈₂ Ni ₁₈	Pt ₇₇ Ni ₂₃	111	0.275	248
Pt ₂₅ Cu ₇₅	Pt ₃₅ Cu ₆₅	-	Pt ₈₇ Cu ₁₃	Pt ₉₈ Cu ₂	72	0.340	472

Table 2: Comparison of bulk and surface composition as well as fuel cell performance parameters of dealloyed Pt-M catalysts compared to a state-of-art Pt catalyst. Reproduced from ref. (26)

Finally, the performance of electrochemically dealloyed PtNi_3M ($\text{M} = \text{Cu}, \text{Co}, \text{Fe}, \text{Cr}$) ternaries were compared with that of the dealloyed binary PtNi_3 ORR catalyst and that of a state-of-the-art commercial 45wt% Pt/C catalyst, Figure 10. From the Figure it is apparent that PtNi_3Co and PtNi_3Cu outperform commercial 45wt% Pt/C catalysts, whereas PtNi_3Fe and PtNi_3Cr show comparable performance even with only 1/3 of geometric Pt loading of the commercial catalysts. No mass transport limitations were discernible over the entire current density range.

Comparing the mass and specific ORR activities in Table 3 in the kinetic region, there is clear synergy between the Pt-Ni bimetallic alloy and additional third alloying components. The largest activity advantage over PtNi_3 was observed for PtNi_3Co and PtNi_3Cu ternaries with a Pt mass activity improvement of 1.7 times over PtNi_3 . PtNi_3Cr still showed 1.3 times improvement and PtNi_3Fe showed negligible advantage in mass activity over the Pt-Ni compounds. Synergistic effects of combining Co, Cu or Cr with the PtNi_3 amounted to previously unobserved and unprecedented Pt mass activity improvements of a factor of 5x for PtNi_3Co and PtNi_3Cu and 3.5 times for PtNi_3Cr compared to pure Pt.

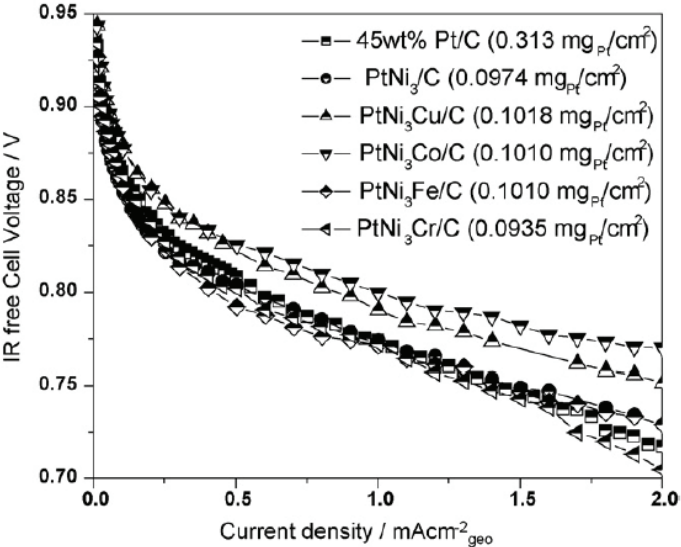


Figure 10: Current-voltage characteristics (polarization behavior) of 10 cm² single H_2/O_2 fuel cells using various dealloyed ternaries Pt cathode catalyst, in comparison with a dealloyed PtNi and a standard Pt cathode catalyst. Reproduced from ref. (26)

Nominal composition	EDS composition (as prepared) [at %]	XPS composition (as prepared) [at %]	ICP composition (after dealloying) [at %]	XPS composition (after dealloying) [at %]	ECSA _{Pt} [m ² /g _{Pt}]	Mass activity @ 0.9V [A/mg _{Pt}]	Specific activity @ 0.9V [μA/cm ² _{Pt}]
Pt	-	-	-	-	63	0.104	166
Pt ₂₅ Ni ₇₅	Pt ₁₈ Ni ₈₂	Pt ₃₈ Ni ₆₂	Pt ₈₂ Ni ₁₈	Pt ₇₇ Ni ₂₃	111	0.275	248
Pt ₂₀ Ni ₆₀ Cu ₂₀	Pt ₁₉ Ni ₅₆ Cu ₂₅	Pt ₃₈ Ni ₄₀ Cu ₂₂	Pt ₈₂ Ni ₁₅ Cu ₃	Pt ₄₈ Ni ₄₈ Cu ₄	116	0.473	406
Pt ₂₀ Ni ₆₀ Co ₂₀	Pt ₁₄ Ni ₆₅ Co ₂₁	Pt ₄₁ Ni ₃₇ Co ₂₂	Pt ₈₆ Ni ₁₁ Co ₃	Pt ₄₅ Ni ₄₉ Co ₆	145	0.472	326
Pt ₂₀ Ni ₆₀ Fe ₂₀	Pt ₂₀ Ni ₆₀ Fe ₂₀	-	-	-	65	0.289	447
Pt ₂₀ Ni ₆₀ Cr ₂₀	Pt ₁₄ Ni ₄₉ Cr ₃₇	-	Pt ₇₅ Ni ₃ Cr ₂₂	-	92	0.366	396

Table 3: Comparison of bulk and surface composition as well as fuel cell performance parameters of dealloyed ternary Pt-Ni-M catalysts compared to the PtNi3 and a state-of-art Pt catalyst. Reproduced from ref. (26)

8. Conclusions

Dealloyed Pt alloy nanoparticles are a highly promising class of electrocatalysts for the electroreduction of molecular oxygen (ORR) at cathodes of PEMFC.

The active phase of the electrocatalysts is prepared by selective dissolution of non noble atoms from nanoparticle precursor. This can be achieved by electrochemical cycling as well as via a facile acid leaching wash requiring simple experimental procedures.

The long term stability of dealloyed Pt electrocatalysts has been a research focus and great progress has been achieved recently, in particular through the preparation of highly size-controlled alloy precursor particle catalysts. Very recent reports demonstrated that dealloyed Pt-Ni ORR catalysts successfully meet the 2017 activity and stability targets set by the Department of Energy's Hydrogen Fuel Cell Program, involving 30,000 potential cycles while maintaining a mass based activity above 0.44 A/mg(Pt) at 900 mV cell voltage(45).

Current issues in dealloyed ORR catalysts involve the impact of the dealloying procedure on the structure of the membrane-electrode-assembly at the meso- and macro scale (swelling, rupture, deformation, residual metal ion concentration in membrane and anode). Similarly, the performance of dealloyed Cathode catalyst in air and low humidity conditions has to be investigated in more detail.

Overall, aside from being a promising cathode catalyst for single MEAs and Fuel cell Stacks, dealloyed ORR Pt core-shell catalysts, in their as-prepared or dealloyed form, lend themselves excellently to further applied or fundamental fuel cell catalysis research. Thanks to the development of industrial scale-up methods, a number of dealloyed Pt ORR catalysts have now become available commercially in larger quantities for industrial or academic fuel cell developers and fundamental and applied academic researchers alike.

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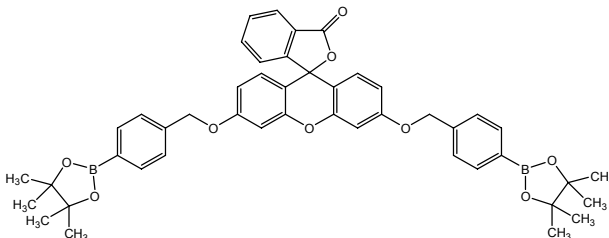
BORON Compounds

96-0350 Biological Hydrogen Peroxide Imaging Kit (FBBBE, CBBE)

NEW→ SEE KITS SECTION (page 79)

05-0058 3',6'-Bis{[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)oxy]-3H-[spiro(isobenzofuran-1,9,-xanthen)-3-one]} FBBBE

5mg

C₄₆H₄₆B₂O₉; FW: 764.47; faint yellow powdr.

Note: Sold under license from The Reagents of the University of California. US Patent application 61/762,706. Biological Hydrogen Peroxide Imaging Kit (FBBBE, CBBE) component. See (page 79).

05-1035 Tetrakis(dimethylamino)diboron [1630-79-1]

C₈H₂₄B₂N₄; FW: 197.93; colorless liq.; b.p. 55-57° (2.5mm);

f.p. 99°C; d. 0.926

moisture sensitive

1g

5g

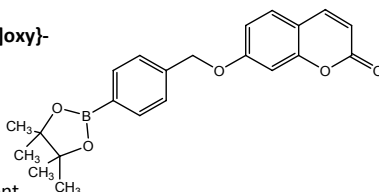
05-0054 7-[[[4,4,5,5-Tetramethyl-1,3,2-dioxaborolan-2-yl)benzyl]oxy]-2H-1-benzopyran-2-one CBBE

5mg

C₂₂H₂₃BO₅; FW: 378.23;

white powdr.

Note: Sold under license from The Reagents of the University of California. US Patent application 61/762,706. Biological Hydrogen Peroxide Imaging Kit (FBBBE, CBBE) component. See (page 79).



CADMIUM Compounds

48-1053 Cadmium selenide/cadmium sulfide CANdots® quantum rod (CdSe/CdS elongated core/shell), 5 mg/ml in hexane, 560nm peak emission

NEW→

SEE NANOMATERIALS SECTION (page 54)

48-1056 Cadmium selenide/cadmium sulfide CANdots® quantum rod (CdSe/CdS elongated core/shell), 5 mg/ml in hexane, 590nm peak emission

NEW→

SEE NANOMATERIALS SECTION (page 54)

48-1059 Cadmium selenide/cadmium sulfide CANdots® quantum rod (CdSe/CdS elongated core/shell), 5 mg/ml in hexane, 620nm peak emission

NEW→

SEE NANOMATERIALS SECTION (page 55)

96-0813 Cadmium selenide/cadmium sulfide CANdots® quantum rod kit, 5 mg/ml in hexane, 560nm, 590nm, 620nm peak emissions

NEW→

SEE KITS SECTION (page 80)

CARBON Elemental forms

06-0274 Graphene film, monolayer, on copper foil (1cm x 1cm)

2pcs

NEW→

[1034343-98-0]

foil

100% coverage, >95% single atomic layer

Average grain (crystal/domain) size:

>~100 micron

Average sheet resistance (on non-conductive substrate):

400 OPS (+/- 200 OPS)

Average transmission: T >96% (on transparent substrate, i.e. ~4% lower than substrate T

COBALT Compounds

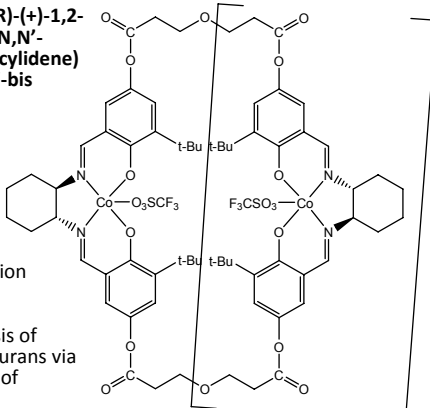
27-0495

NEW→

Cyclic-Oligo Bis[(1R,2R)-(+)-1,2-cyclohexanediamino-N,N'-bis(3,3'-di-t-butyl-salicylidene)cobalt(III)triflate]-5,5'-bis(2-carboxyethyl) ether [647036-07-5]
 $C_{70}H_{84}Co_2F_6N_4O_{20}S_2$;
 FW: 1597.42;
 black xtl.

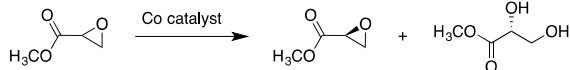
100mg

500mg



Technical Notes:

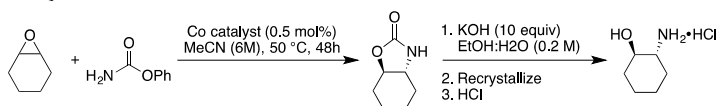
- Oligomeric catalyst used for the hydrolytic kinetic resolution of terminal epoxides under solvent-free conditions.
- Catalyst used for the synthesis of enantioenriched tetrahydrofurans via the intramolecular openings of oxetanes.
- Catalyst for the enantioselective addition of phenyl carbamate to meso-epoxides for the synthesis of *trans*-1,2-amino alcohols.



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)



Tech. Note (3)
Ref. (3)

References:

- Tetrahedron: Asymmetry*, **2003**, *14*, 3633.
- J. Am. Chem. Soc.*, **2009**, *131*, 2786.
- Org. Lett.*, **2013**, *15*, 2895.

27-0496

NEW→

Cyclic-Oligo Bis[(1S,2S)-(-)-1,2-cyclohexanediamino-N,N'-bis(3,3'-di-t-butylsalicylidene)cobalt(III)triflate]-5,5'-bis(2-carboxyethyl)ether [1252661-94-1]
 $C_{70}H_{84}Co_2F_6N_4O_{20}S_2$; FW: 1597.42; black xtl.

100mg

500mg

Technical Note:

- See 27-0495 (page 46).

COPPER Compounds

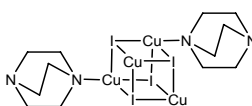
29-3015

NEW→

Bis(1,4-diazabicyclo[2.2.2]octane) tetra(copper(I) iodide) MOF $(CuI)_4(DABCO)_2$ [928170-42-7]
 $C_{12}H_{24}Cu_4I_4N_4$; FW: 986.15;
 yellow powder.
 air sensitive

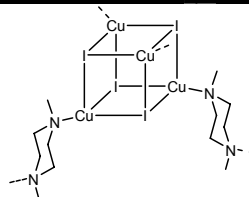
500mg

2g



COPPER Compounds

29-0550 **Bis(N,N'-dimethylpiperazine)tetra**
NEW→ **[copper(I) iodide], 98% MOF** [1401708-91-5]
 $(\text{CuI})_4(\text{C}_6\text{H}_{14}\text{N}_2)_2$; FW: 990.18; white powdr.
moisture sensitive, (store cold)



500mg
2g

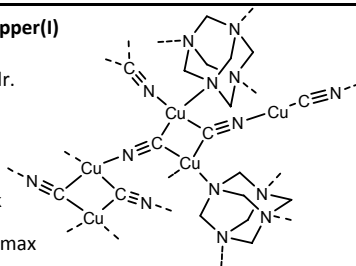
Technical Note:

1. The copper iodide, N,N'-dimethylpiperazine complex is a 3D photo-luminescent, fairly open network, with a λ_{max} excitation of 321 nm and a λ_{max} emission of 525nm.

Reference:

1. *Dalton Trans.*, **2012**, 41, 11663.

29-0565 **(Hexamethylenetetramine)penta[copper(I)**
NEW→ **cyanide], 98% MOF** [1042093-98-0]
 $\text{C}_6\text{H}_{12}(\text{CuCN})_5$; FW: 588.00; white powdr.
hygroscopic, (store cold)



500mg
2g

Technical Note:

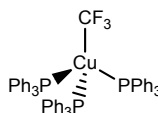
1. The copper cyanide hexamethylene tetramine complex is a 3D photo-luminescent, very densely-packed, network of tetradentate ligands with a λ_{max} excitation of 282 and 304 nm, and a λ_{max} emission of 417 and 522nm.

References:

1. *Inorg. Chem.*, **2007**, 46, 8897.
2. *Inorg. Chem.*, **2008**, 47, 6947.
3. *Inorg. Chim. Acta.*, **2010**, 364, 102.
4. *Dalton Trans.*, **2012**, 41, 11663.

19-3025 **Potassium dicyanocuprate**
NEW→ *SEE POTASSIUM SECTION (page 70)*

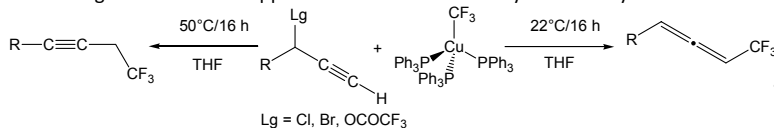
29-2955 **Tris(triphenylphosphine)(trifluoromethyl)**
NEW→ **copper(I), 99%** [325810-07-9]
 $\text{C}_{55}\text{H}_{45}\text{CuF}_3\text{P}_3$; FW: 919.41; white xtl.
air sensitive



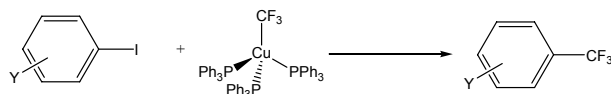
1g
5g

Technical Notes:

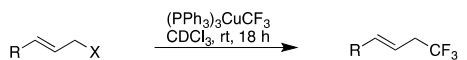
1. Reagent used in the copper-mediated trifluoromethylation of propargylic halides and trifluoroacetates.
2. Reagent used in a high-yielding simple preparation of trifluoromethylaromatics from iodides.
3. Reagent used in the copper-mediated trifluoromethylation of allylic chlorides and trifluoroacetates.



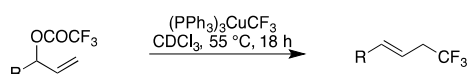
Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)



Tech. Note (3)
Ref. (3)



References:

1. *Org. Lett.*, **2012**, 74, 3966.
2. *Angew. Chem. Int. Ed.*, **2011**, 50, 7655.
3. *J. Org. Chem.*, **2013**, 78, 7330.

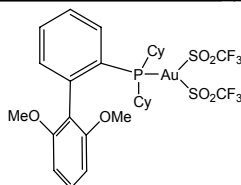
CYLINDERS & ADAPTERS Other

96-1075 Swagelok® Cylinder Assembly, 50ml with " VCR Male Ball Valve and Female Nut, electropolished for CVD/ALD 1cyl
NEW→

96-1076 Swagelok® Cylinder Assembly, 50ml with " VCR Male Bellows-Sealed Valve (High Temp) and Female Nut, electropolished for CVD/ALD 1cyl
NEW→

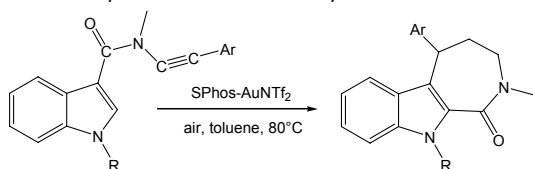
GOLD Compounds

79-0230 Bis(trifluoromethanesulfonyl) imide(2-dicyclohexylphosphino-2',6'-dimethoxy-1,1'-biphenyl) gold(I), 98% [1121960-90-4] 100mg
NEW→ $C_{28}H_{35}AuF_6NO_6PS_2$; FW: 887.64; 500mg
 white to off-white solid

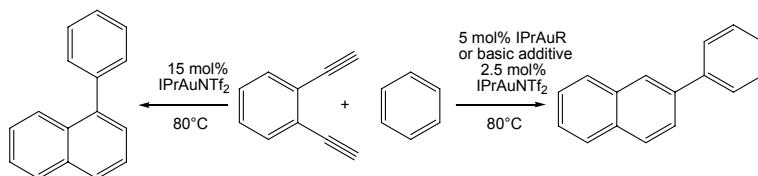


Technical Notes:

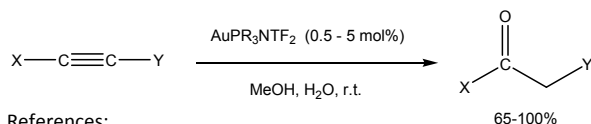
1. Highly-efficient and regio-selective catalyst for the selective carbonyl migration in alkynyl-substituted indole-3-carboxamides.
2. Catalyst used in the hydroarylation/aromatization of arene-diyne.
3. Catalyst used in the selective hydration of substituted alkynes at room temperatures.



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

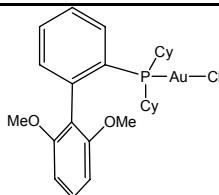


Tech. Note (3)
Ref. (3)

References:

1. *Adv. Synth. Catal.*, **2012**, 354, 1273.
2. *Organometallics*, **2012**, 31, 644.
3. *J. Org. Chem.*, **2009**, 74, 2067.

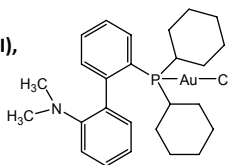
79-0225 Chloro(2-dicyclohexylphosphino-2',6'-dimethoxy-1,1'-biphenyl)gold(I), 98% 250mg
NEW→ [854045-95-7] 1g
 $C_{26}H_{35}AuClO_2P$; FW: 642.95; white powdr.



Technical Note:

1. See 79-0230 (page 48).

79-0343 Chloro[2-(dicyclohexylphosphino)-2'-(N,N-dimethylamino)biphenyl]gold(I), 98% [1196707-11-5] 250mg
NEW→ $C_{26}H_{36}AuClNP$; FW: 625.96; 1g
 white powdr.

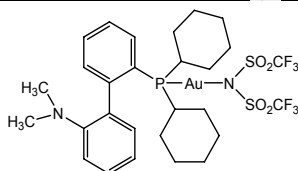


Technical Note:

1. See 79-0348 (page 49).

GOLD Compounds

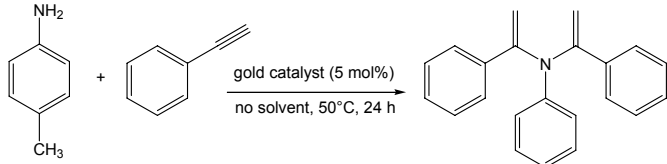
79-0348 [2-(Dicyclohexylphosphino)-
NEW→ 2'-[N,N-dimethylamino)biphenyl]
 [bis(trifluoromethyl) sulfonylimido]
 gold(I), 98% [1188507-66-5]
 $C_{28}H_{36}AuF_6N_2O_4PS_2$; FW: 870.66;
 yellow powdr.



250mg
1g

Technical Note:

1. Catalyst used in the formation of a bisenamine from toluidine and phenylacetylene.

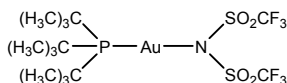


Tech. Note (1)
Ref. (1)

Reference:

1. *J. Org. Chem.*, **2010**, *75*, 7769.

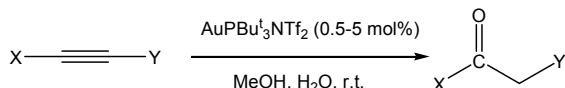
79-0355 Tri-*t*-butylphosphine[bis(tri-
NEW→ fluoromethyl)sulfonylimido]
 gold(I), 98% [1121960-93-7]
 $C_{12}H_{27}AuF_6NO_4PS_2$; FW: 679.43;
 white solid



100mg
500mg

Technical Note:

1. Catalyst used for the selective hydration of substituted alkynes at room temperature.



Tech. Note (1)
Ref. (1)

Reference:

1. *J. Org. Chem.*, **2009**, *74*, 2067.

HAFNIUM Compounds

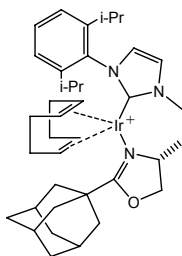
98-4022 Tetrakis(dimethylamino)hafnium, 98+% (99.99+% Hf, <0.2%-Zr)
NEW→ TDMAH, PURATREM, 72-8000, contained in 50ml Swagelok®
 HAZ cylinder (96-1071) for CVD/ALD [19962-11-9]
 $Hf(N(CH_3)_2)_4$; FW: 354.79; colorless to pale yellow xtl.
 moisture sensitive, (store cold)

25g

IRIDIUM Compounds

96-7710 SpinPHOX-Ir Catalyst Kit for enantioselective hydrogenation
NEW→ SEE KITS SECTION (page 81)

77-5030 {1-[(4R)-2-(1-Adamantyl-4,5-dihydrooxazolyl)
NEW→ ethyl]-3-(2,6-di-*i*-propylphenyl)imidazolin-
 2-ylidene}(1,5-cyclooctadiene)iridium(I)
 tetrakis[3,5-bis(trifluoromethyl)phenyl]
 borate, 99% [934621-82-6]
 $C_{70}H_{67}BF_{24}IrN_3O$; FW: 1623.27; orange solid



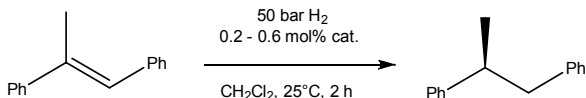
50mg
250mg

Technical Note:

1. Catalyst used for the asymmetric hydrogenation of aryl alkenes.

IRIDIUM Compounds

77-5030 {1-[(4R)-2-(1-Adamantyl-4,5-dihydrooxazolyl)ethyl]-3-(2,6-di-i-propylphenyl)imidazolin-2-ylidene}(1,5-cyclooctadiene)iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl] borate, 99% [934621-82-6]
NEW→ (cont.)



Tech. Note (1)
Ref. (1)

Reference:

1. *J. Am. Chem. Soc.*, **2001**, *123*, 8878.

77-5031 {1-[(4S)-2-(1-Adamantyl-4,5-dihydrooxazolyl)ethyl]-3-(2,6-di-i-propylphenyl)imidazolin-2-ylidene}(1,5-cyclooctadiene)iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl]borate, 99% [369657-32-9]
NEW→

50mg
250mg

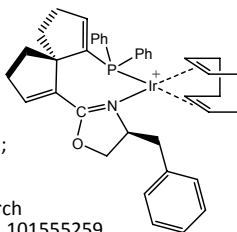
C₇₀H₆₅BF₂₄IrN₃O; FW: 1623.27; orange solid

Technical Note:

1. See 77-5030 (page 49).

77-5040 1,5-Cyclooctadiene{(4S)-(+)-2-[(5S)-6-(diphenylphosphino)spiro[4.4]nona-1,6-dien-1-yl]-4,5-dihydro-4-benzyl-oxazole}iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl]borate, 97% (S,S)-(COD)Ir[Bn-SpinPHOX] [1194050-19-5]
NEW→ C₃₉H₄₂IrNOP(C₃₂H₁₂BF₂₄); FW: 1627.16; red solid; [α]_D +63.7° (c 1.0, CHCl₃); m.p. 49-51°
air sensitive

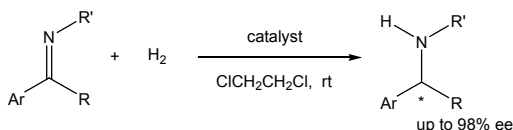
Note: Sold in collaboration with SIOC for research purposes only. Patents CN200910051314.3, CN 101555259. SpinPHOX-Ir Catalyst Kit component. See (page 81).



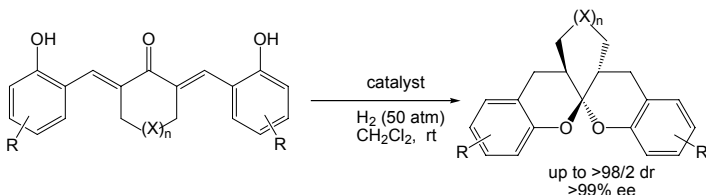
25mg
100mg

Technical Note:

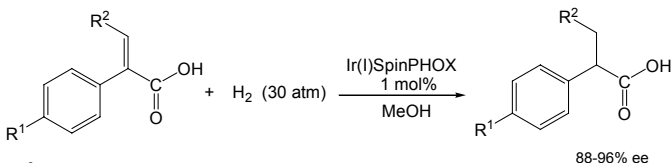
1. Highly efficient catalyst for the enantioselective hydrogenation of a diverse class of ketimines and α,β-unsaturated substrates.



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)



Tech. Note (3)
Ref. (3)

References:

1. *Angew. Chem. Int. Ed.*, **2009**, *48*, 5345.
2. *Angew. Chem. Int. Ed.*, **2012**, *51*, 936.
3. *Chem. Commun.*, **2010**, *46*, 156.

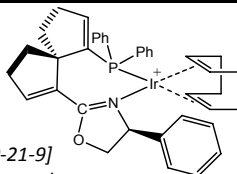
IRIDIUM Compounds

- 77-5041** 1,5-Cyclooctadiene((4S)-(-)-2-[(5R)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-benzoxazole} iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl]borate, 97% (R,S)-(COD)Ir[Bn-SpinPHOX] [1195511-56-8] 25mg
 100mg
 C₃₉H₄₂IrNOP(C₃₂H₁₂BF₂₄); FW: 1627.16; red pwdr.;
 $[\alpha]_D$ -2.9° (c 1.0, CHCl₃); m.p. 103-105° *air sensitive*
 Note: Sold in collaboration with SIOC for research purposes only.
 Patents CN200910051314.3, CN 101555259. SpinPHOX-Ir Catalyst Kit component. See (page 81).

Technical Note:

- See 77-5040 (page 50).

- 77-5046** 1,5-Cyclooctadiene((4S)-(+)-2-[(5S)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-phenyloxazole}iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl]borate, 97% (S,S)-(COD)Ir[Ph-SpinPHOX] [1194050-21-9] 25mg
 100mg
 C₃₈H₄₀IrNOP(C₃₂H₁₂BF₂₄); FW: 1613.13; orange pwdr.;
 $[\alpha]_D$ +97.2° (c 1.0, CHCl₃); m.p. 197-198° *air sensitive*
 Note: Sold in collaboration with SIOC for research purposes only.
 Patents CN200910051314.3, CN 101555259. SpinPHOX-Ir Catalyst Kit component. See (page 81).



Technical Note:

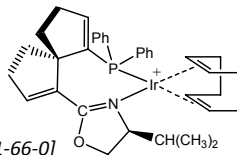
- See 77-5040 (page 50).

- 77-5047** 1,5-cyclooctadiene((4S)-(-)-2-[(5R)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-phenyloxazole} iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl]borate, 97% (R,S)-(COD)Ir[Ph-SpinPHOX] [1195511-59-1] 25mg
 100mg
 C₃₈H₄₀IrNOP(C₃₂H₁₂BF₂₄); FW: 1613.13; red pwdr.;
 $[\alpha]_D$ -10.8° (c 1.0, CHCl₃); m.p. 172-174° *air sensitive*
 Note: Sold in collaboration with SIOC for research purposes only.
 Patents CN200910051314.3, CN 101555259. SpinPHOX-Ir Catalyst Kit component. See (page 81).

Technical Note:

- See 77-5040 (page 50).

- 77-5051** 1,5-cyclooctadiene((4S)-(-)-2-[(5R)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-(i-propyl)oxazole}iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl]borate, 97% (R,S)-(COD)Ir[iPr-SpinPHOX] [1195511-66-0] 25mg
 100mg
 C₃₅H₄₂IrNOP(C₃₂H₁₂BF₂₄); red-orange pwdr.;
 $[\alpha]_D$ -9° (c 0.37, CHCl₃); m.p. 172-173° *air sensitive*
 Note: Sold in collaboration with SIOC for research purposes only.
 Patents CN200910051314.3, CN 101555259. SpinPHOX-Ir Catalyst Kit component. See (page 81).



Technical Note:

- See 77-5040 (page 50).

IRIDIUM Compounds

77-5050

NEW→

1,5-cyclooctadiene{(4S)-(+)-2-[(5S)-6-(diphenylphosphino)spiro[4.4]nona-1,6-dien-1-yl]-4,5-dihydro-4-(i-propyl)oxazole}iridium(I) tetrakis [3,5-bis(trifluoromethyl)phenyl]borate, 97% (S,S)-(COD)Ir[iPr-SpinPHOX]

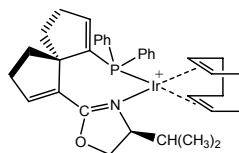
[1194050-23-1]

C₃₅H₄₂IrNOP(C₃₂H₁₂BF₂₄); red-orange powdr.;[α]_D +77.6° (c 1.0, CHCl₃); m.p. 201-203°

air sensitive

Note: Sold in collaboration with SIOC for research purposes only.

Patents CN200910051314.3, CN 101555259. SpinPHOX-Ir Catalyst Kit component. See (page 81).



25mg

100mg

Technical Note:

1. See 77-5040 (page 50).

IRON Compounds

26-1640

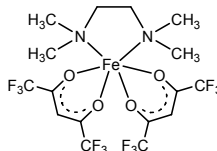
NEW→

Bis(hexafluoroacetylacetonato) (N,N,N',N'-tetramethylethylenediamine) iron(II), min. 98% [73450-43-8]

C₁₆H₁₈F₁₂FeN₂O₄; FW: 586.15;

black xtl.

Note: Sold under license from Università degli Studi di Padova for research purposes only. Int. Patent App. PCT/IT2012/000276. Italian Patent App. PD2011A000285.



100mg

500mg

Technical Note:

1. Volatile iron complex used in the CVD of iron oxide thin films.

Reference:

1. *Inorg. Chim. Acta.*, **2012**, *380*, 161.

26-0145

NEW→

amp

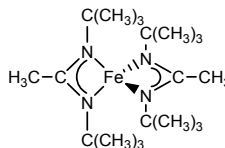
Bis(N,N'-di-t-butylacetamidinato) iron (II), min. 98% [635680-56-7]

C₂₀H₄₂N₄Fe; FW: 394.42;

off-white to gray xtl.; m.p. 107°

air sensitive

Note: Extremely air-sensitive. Contact Strem to discuss. Product sold under, use subject to, terms and conditions of label license at www.strem.com/harvard2.



250mg

1g

5g

Technical Notes:

1. Iron amidinate used in the chemical vapor deposition of iron, iron carbides and iron nitride films.
2. Precursor for the MOCVD of iron-containing thin films.

References:

1. *J. Electrochem. Soc.*, **2010**, *157*, D454.
2. *ECS Transactions*, **2009**, *25*, 181.

IRON Compounds

26-0243

NEW→

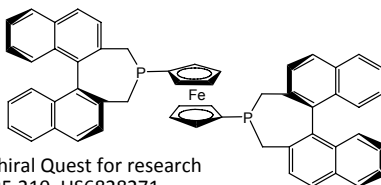
1,1'-Bis[(S)-4,5-dihydro-3H-binaphtho[1,2-c:2',1'-e]phosphino]ferrocene, min. 98% (S,S)-f-Binaphane [544461-38-3]

C₅₄H₄₀FeP₂; FW: 806.69;

yellow-brown powdr.

air sensitive, light sensitive

Note: Sold in collaboration with Chiral Quest for research purposes only. US Patent No. 6,525,210, US6828271.

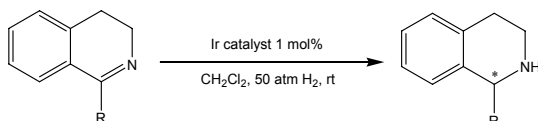


100mg

500mg

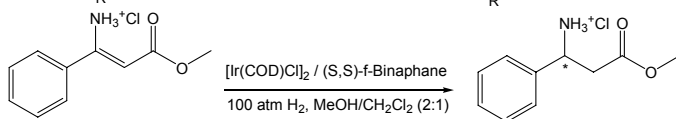
Technical Notes:

1. Ligand used for the asymmetric hydrogenation of 3,4-dihydroisoquinolines.
2. Ligand used for the preparation of a highly-efficient iridium catalyst for the asymmetric hydrogenation of β -enamine esters.
3. Ligand used for the enantioselective hydrogenation of N-H imines.



Tech. Note (1)

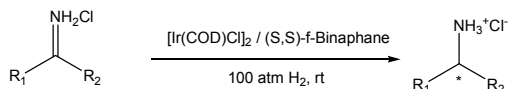
Ref. (1)



Tech. Note (2)

Ref. (2)

r.t, S/C = 1,000 >99% conv. 95% ee
40°C, S/C = 5,000 >99% conv. 94% ee
40°C, S/C = 10,000 87% conv. 94% ee



Tech. Note (3)

Ref. (3)

References:

1. *Angew. Chem. Int. Ed.*, **2011**, 50, 10679.
2. *J. Am. Chem. Soc.*, **2010**, 132, 12844.
3. *J. Am. Chem. Soc.*, **2009**, 131, 9882.

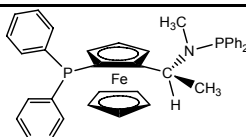
26-2515

NEW→

(R)-1-[(S)-2-Diphenylphosphinoferrocenyl] (N-methyl)(N-diphenylphosphino)ethylamine (R)-Me-Bophoz [406680-94-2]

C₃₇H₃₅FeNP₂; FW: 611.50

Note: Sold in collaboration with JM for research purposes only.

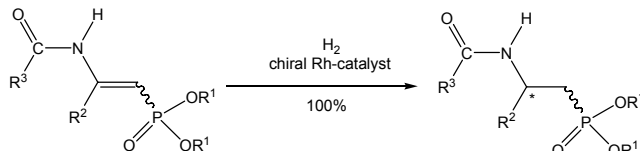


100mg

500mg

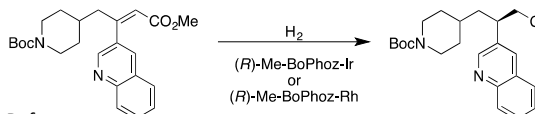
Technical Notes:

1. Ligand used in the rhodium-catalyzed, asymmetric hydrogenation of β -amido-vinylphosphonates.
2. Ligand used in the rhodium or iridium-catalyzed asymmetric hydrogenation of α,β -unsaturated esters.



Tech. Note (1)

Ref. (1)



Tech. Note (2)

Ref. (2)

References:

1. *Tetrahedron Asymm.*, **2008**, 19(10), 1189. up to 95% ee
2. *Tetrahedron Asymm.*, **2008**, 19(10), 938.
3. *J. Org. Chem.* **2005**, 70, 1872.

IRIDIUM Compounds

26-2516	(S)-1-[(R)-2-Diphenylphosphinoferrocenyl](N-methyl)(N-diphenylphosphino)ethylamine (S)-Me-Bophoz [406681-09-2]	100mg
NEW→	C₃₇H₃₅FeNP₂ ; FW: 611.50	500mg
	Note: Sold in collaboration with JM for research purposes only.	

Technical Note:

1. See 25-2515 (page 53).

MAGNESIUM Compounds

12-1045	Bis(pentamethylcyclopentadienyl)magnesium, min. 98%	500mg
NEW→	[74507-64-5]	2g
amp	[(CH ₃) ₅ C ₅] ₂ Mg; white to yellow xtl.	
HAZ	air sensitive, moisture sensitive	

MOLYBDENUM Compounds

42-7500	Trichlorotris(tetrahydrofuran)molybdenum(III), min. 95%	1g
NEW→	[74507-64-5]	5g
HAZ	MoCl ₃ (C ₄ H ₈ O) ₃ ; FW: 418.62; light orange solid	
	moisture sensitive	

NANOMATERIALS Elemental forms

06-0274	Graphene film, monolayer, on copper foil (1cm x 1cm)
NEW→	SEE CARBON SECTION (page 46)

NANOMATERIALS Compounds

48-1053	Cadmium selenide/cadmium sulfide CANdots® quantum rod (CdSe/CdS elongated core/shell), 5 mg/ml in hexane, 560nm peak emission [1306-24-7]	0.5ml
NEW→		2ml
HAZ	CdSe/CdS; dispersed, yellow solution	
	(store cold)	
	Note: Sold in collaboration with CAN for research purposes.	
	Technical Note: Stability: Store at 2-8°C in dark under inert atmosphere. Do not freeze. Safety: Hazardous - an additional Dangerous Goods freight charge may apply. CANdots® Series A Plus Quantum Rod Kit component. See (page 80).	
48-1056	Cadmium selenide/cadmium sulfide CANdots® quantum rod (CdSe/CdS elongated core/shell), 5 mg/ml in hexane, 590nm peak emission [1306-24-7]	0.5ml
NEW→		2ml
HAZ	CdSe/CdS; dispersed, orange solution	
	(store cold)	
	Note: Sold in collaboration with CAN for research purposes.	
	Technical Note: Stability: Store at 2-8°C in dark under inert atmosphere. Do not freeze. Safety: Hazardous - an additional Dangerous Goods freight charge may apply. CANdots® Series A Plus Quantum Rod Kit component. See (page 80).	

NANOMATERIALS Compounds

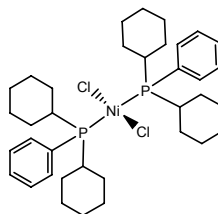
48-1059	Cadmium selenide/cadmium sulfide CANdots® quantum rod	0.5ml
NEW→	(CdSe/CdS elongated core/shell), 5 mg/ml in hexane, 620nm	2ml
HAZ	peak emission [1306-24-7]	
	CdSe/CdS; dispersed, red solution	
	(store cold)	
	Note: Sold in collaboration with CAN for research purposes.	
	Technical Note: Stability: Store at 2-8°C in dark under inert atmosphere. Do not freeze. Safety: Hazardous - an additional Dangerous Goods freight charge may apply. CANdots® Series A Plus Quantum Rod Kit component. See (page 80).	

12-1405	Magnesium oxide nanopowder [1309-48-4]	25g
NEW→	MgO; FW: 40.31; white powdr.; APS 20mm; SSA 50m ² /g	100g

30-1405	Zinc oxide nanopowder [1314-13-2]	25g
NEW→	ZnO; FW: 81.37; white powdr.;m APS 20mm; SSA 50m ² /g	100g

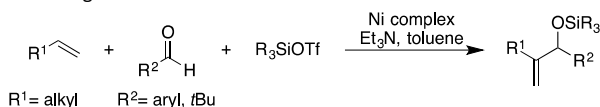
NICKEL Compounds

28-1330	trans-Bis(dicyclohexylphenylphosphino) nickel(II) chloride, 99% [19232-03-2]	250mg
NEW→	C ₃₆ H ₅₄ Cl ₂ NiP ₂ ; FW: 678.40; purple powdr.	1g

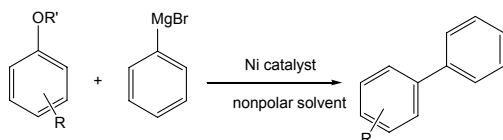


Technical Notes:

1. Catalyst used for the coupling of alkenes, aldehydes, and silyl triflates.
2. Catalyst used for the cross-coupling of aryl Grignard reagents with aromatic ethers.



Tech. Note (1)
Ref. (1,2)

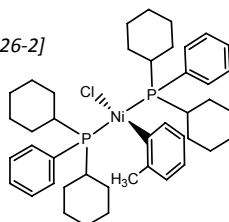


Tech. Note (2)
Ref. (3)

References:

1. *J. Am. Chem. Soc.*, **2005**, 127, 14194.
2. *J. Am. Chem. Soc.*, **2006**, 128, 11513.
3. *Angew. Chem. Int. Ed.*, **2004**, 43, 2428.

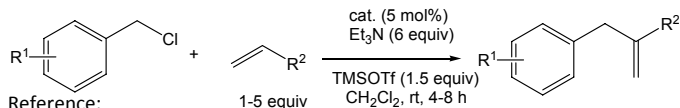
28-0150	Chlorobis(dicyclohexylphenylphosphino) (2-methylphenyl)nickel(II), 99% [1419179-26-2]	100mg
NEW→	C ₄₃ H ₆₁ ClNiP ₂ ; FW: 734.04; purple powdr.	500mg



Technical Note:

1. Air-stable nickel precatalyst for the internally selective benzylation of terminal alkenes.

NICKEL Compounds

28-0150 Chlorobis(dicyclohexylphenylphosphino)(2-methylphenyl)nickel(II), 99% [1419179-26-2]**NEW**
(cont.)1. *J. Am. Chem. Soc.*, **2013**, *135*, 1585.**Tech. Note (1)**
Ref. (1)

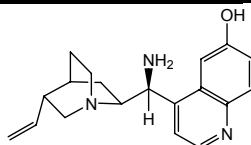
NITROGEN Compounds

07-1712 (8 α , 9S)-(+)-9-Amino-cinchonan-**6'-ol, min. 90%** [960050-59-3]C₁₉H₂₃N₃O; FW: 309.41;

off-white to pale brown powdr.;

[α]_D +107.9° (c 1.0, CHCl₃)

(store cold)



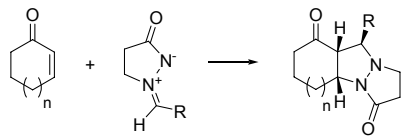
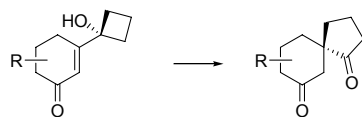
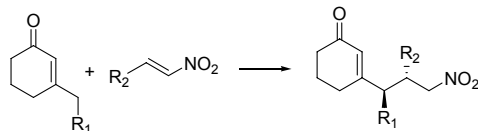
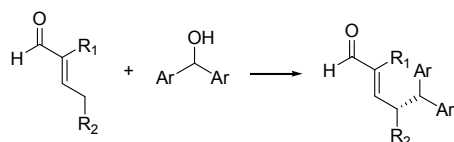
50mg

250mg

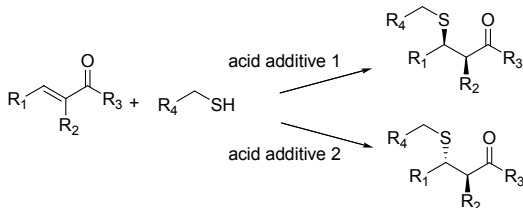
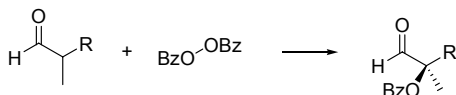
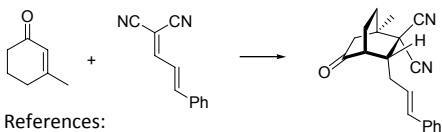
These amino-cinchonnane compounds behave as pseudoenantiomers, generally granting access to both enantiomers of a given transformation.

Technical Notes:

- 1,3-dipolar cycloaddition of cyclic enones and azomethine imines.
- β -activation of α,β -unsaturated carbonyl groups.
 - a.) vinylogous α -ketol rearrangement.
 - b.) vinylogous Michael addition of β -substituted α,β -unsaturated cyclohexanones.
 - c.) Formal γ -alkylation by S_N1 reaction of diarylmethanol with α -branched aldehydes.
- Michael addition: Diastereodivergent Michael addition to α -substituted, α,β -unsaturated ketones.
- α -benzoyloxylation of α -branched aldehydes.
- [4+2]-cycloadditions of β -substituted α,β -unsaturated cyclohexanones with polyconjugated malonitriles.

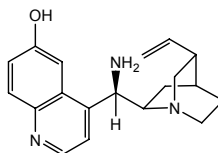
**Tech. Note (1)**
Ref. (1)**Tech. Note (2a)**
Ref. (2)**Tech. Note (2b)**
Ref. (3)**Tech. Note (2c)**
Ref. (4)

NITROGEN Compounds

07-1712 (8 α , 9S)-(+)-9-Amino-cinchonan-6'-ol, min. 90% [960050-59-3]**NEW→**
(cont.)Tech. Note (3)
Ref. (5)Tech. Note (4)
Ref. (6)Tech. Note (5)
Ref. (7)

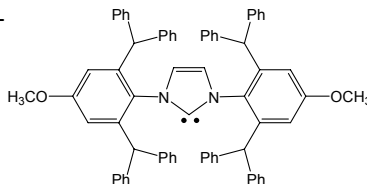
References:

1. *Angew. Chem. Int. Ed.*, **2007**, 46, 7667.
2. *J. Am. Chem. Soc.*, **2009**, 131, 14626.
3. *Proc. Nat. Acad. Sci. USA*, 2010, 107, 20642.
4. *Angew. Chem. Int. Ed.*, **2010**, 49, 9685.
5. *J. Am. Chem. Soc.*, **2011**, 133, 17934.
6. *Tetrahedron*, **2012**, 68, 7568.
7. *J. Am. Chem. Soc.*, **2012**
8. *Angew. Chem. Int. Ed.*, **2012**, 51, 9748. (review)
9. *Nature Protocols*, **2013**, 8, 325. (review)

07-1717 (9R)-(+)-9-Amino-cinchonan-6'-ol, min. 90%
NEW→ [960050-60-6]C₁₉H₂₃N₃O; FW: 309.41;
off-white to pale brown powdr.;
[α]_D +66.9° (c 1.0, CHCl₃)
(store cold)50mg
250mg

Technical Note:

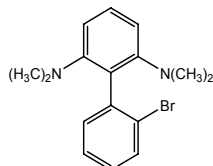
1. See 07-1712 (page 56).

07-0216 N,N'-Bis(2,6-bis(diphenylmethyl)-
NEW→ 4-methoxyphenyl)imidazol-2-
ylidene, min. 98%
HAZC₆₉H₅₆N₂O₂; FW: 945.20;
white powdr.
air sensitive, moisture sensitive250mg
1g

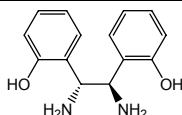
NITROGEN Compounds

07-0230 **1,3-Bis(dimethylamino)benzene, 98% [22440-93-3]** 1g
NEW→ $C_{10}H_{16}N_2$; FW: 164.25; colorless liq. 5g

07-0428 **2,6-Bis(dimethylamino)-2'-bromo-1,1'-biphenyl, min. 98% [1160556-63-7]** 250mg
NEW→ $C_{16}H_{15}BrN_2$; FW: 319.24; brown solid 1g

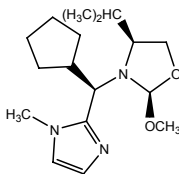


07-6008 **(1R,2R)-1,2-Bis(2-hydroxyphenyl)ethane-1,2-diamine, min. 97% [870991-70-1]** 250mg
NEW→ $C_{14}H_{16}N_2O_2$; FW: 244.29; white to off-white powdr. 1g
air sensitive



07-6009 **(1S,2S)-1,2-Bis(2-hydroxyphenyl)ethane-1,2-diamine, min. 97% [119386-71-9]** 250mg
NEW→ $C_{14}H_{16}N_2O_2$; FW: 244.29; white to off-white powdr. 1g
air sensitive

07-1226 **(2R,4S)-3-[(R)-cyclopentyl(1-methyl-1H-imidazol-2-yl)methyl]-4-(i-propyl)-2-methoxyoxazolidine, 99% [1373441-02-1]** 50mg
NEW→ $C_{17}H_{29}N_3O_2$; FW: 307.43; white powdr. 250mg
air sensitive, moisture sensitive



Technical Note:

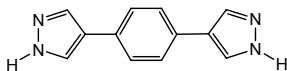
1. See 07-1222 (page 58).

07-1227 **(2S,4R)-3-[(S)-cyclopentyl(1-methyl-1H-imidazol-2-yl)methyl]-4-(i-propyl)-2-methoxyoxazolidine, 99%** 50mg
NEW→ $C_{17}H_{29}N_3O_2$; FW: 307.43; white powdr. 250mg
air sensitive, moisture sensitive

Technical Note:

1. See 07-1222 (page 58).

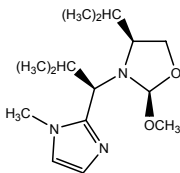
07-0435 **1,4-Di(4'-pyrazolyl)benzene, min. 97% [1036248-62-0]** 100mg
NEW→ $C_{12}H_{10}N_4$; FW: 210.24; pale yellow solid 500mg



Technical Note:

1. Ligand for MOF synthesis.

07-1222 **(2R,4S)-3-[(R)-(i-propyl)(1-methyl-1H-imidazol-2-yl)methyl]-4-(i-propyl)-2-methoxyoxazolidine, 99%** 50mg
NEW→ $C_{15}H_{27}N_3O_2$; white solid 250mg
air sensitive, moisture sensitive

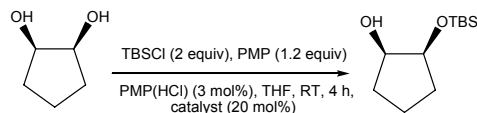


Technical Notes:

1. Scaffolding catalyst used in a silyl transfer reaction.
2. Scaffolding catalyst used for the regiodivergent resolution on a racemic mixture.

NITROGEN Compounds

07-1222 **(2R,4S)-3-[(R)-(i-propyl)(1-methyl-1H-imidazol-2-yl)methyl]-4-(i-propyl)-2-methoxyoxazolidine, 99%** [1334170-82-9]
NEW→
 (cont.)



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

References:

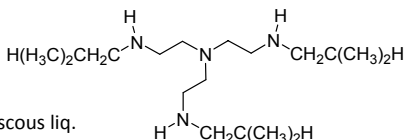
1. *Angew. Chem. Int. Ed.*, **2011**, 50, 8167.
2. *J. Am. Chem. Soc.*, **2012**, 134, 7321.
3. *Nature Chem.* **2013**, 5, 790.

07-1223 **(2S,4R)-3-[(S)-(i-propyl)(1-methyl-1H-imidazol-2-yl)methyl]-4-(i-propyl)-2-methoxyoxazolidine, 99%** 50mg
NEW→ 250mg
 $C_{15}H_{27}N_3O_2$; FW: 281.39; white solid
air sensitive, moisture sensitive

Technical Note:

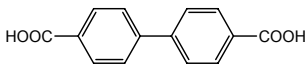
1. See 07-1222 (page 58).

07-3110 **Tris(isobutylaminoethyl) amine, min 97%** 500mg
NEW→ 2g
 [331465-73-7]
 $C_{18}H_{42}N_4$; FW: 314.55;
 colorless to pale yellow, viscous liq.
hygroscopic

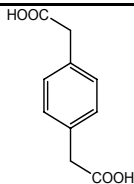


OXYGEN Compounds

08-0175 **[1,1'-Biphenyl]-4,4'-dicarboxylic acid, min. 98%** 5g
NEW→ [787-70-2] 25g
 $C_{14}H_{10}O_4$; FW: 242.23;
 white to pale-yellow solid



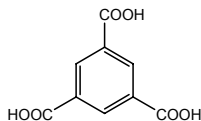
08-1165 **1,4-Phenylenediacetic acid, 97%** [7325-46-4] 1g
NEW→ $C_8H_8(CH_2COOH)_2$; FW: 194.18; 5g
 white to off-white solid



Technical Note:

1. Ligand for MOF synthesis.

08-0195 **1,3,5-Tricarboxybenzene, min. 95%** 50g
NEW→ (Trimesic acid) [554-95-0] 250g
 $C_6H_3(COOH)_3$; FW: 210.14;
 white powder.



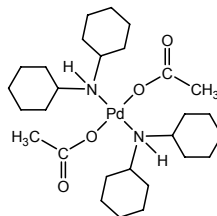
Technical Note:

1. Ligand for MOF synthesis.

PALLADIUM Compounds

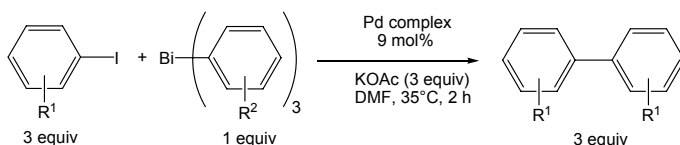
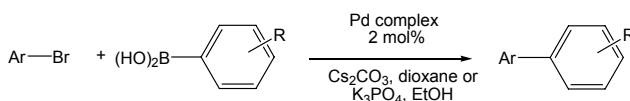
46-0228 **trans-Bis(dicyclohexylamine)bis(acetato)****NEW→****palladium(II) DAPCy [628339-96-8]**Pd[(C₆H₁₁)₂NH]₂(CH₃COO)₂;

FW: 587.14; yellow xtl.

250mg
1g

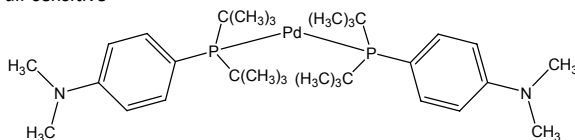
Technical Notes:

1. Pd-catalyzed coupling of aryl iodides with triarylbi-muths.
2. Pd-catalyzed Suzuki Coupling Reactions of aryl bromides under mild aerobic conditions.

Tech. Note (1)
Ref. (1)Tech. Note (2)
Ref. (2)

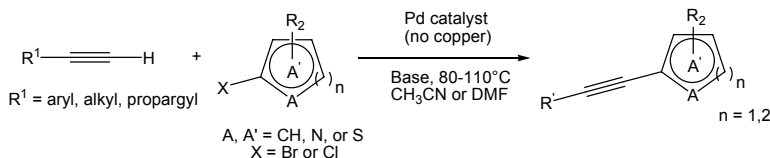
References:

1. *Tetrahedron Lett.*, **2010**, 51, 6101.
2. *J. Org. Chem.*, **2004**, 69, 4330.

46-0828 **Bis[4-(N,N-dimethyl-amino)phenyl]di-t-butylphosphino}****NEW→****palladium(0), min. 98% PdAMPHOS [1233717-68-4]**C₃₂H₅₆N₂P₂Pd; FW: 637.17; white pwdr.*air sensitive*250mg
1g

Technical Note:

1. Catalyst used for the Heck alkylation of aryl and heteroaryl chlorides.

Tech. Note (1)
Ref. (1)

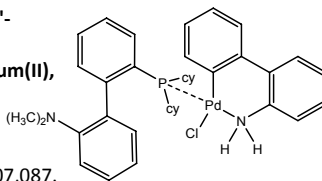
Reference:

1. *J. Org. Chem.*, **2013**, 78, 568.

46-0232 **Chloro[2-(dicyclohexylphosphino)-2'-(N,N-dimethylamino)-1,1'-biphenyl] (2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [DavePhos Palladacycle]****NEW→**C₃₈H₄₆ClN₂PPd; FW: 703.63;

white pwdr.

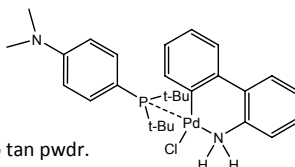
Note: Patents: US 6,395,916, US 6,307,087.

250mg
1g

PALLADIUM Compounds

46-0342 Chloro[[4-(N,N-dimethylamino)phenyl]di-*t*-butyl-phosphino]phenyl][2'-amino-1,1'-biphenyl-2-yl] palladium(II), min. 98% [amphos Palladacycle]

C₂₈H₃₈ClN₂PPd; FW: 575.46; beige to tan powdr.



250mg
1g

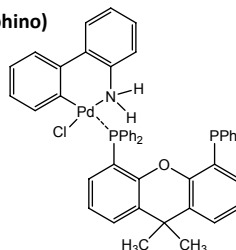
Technical Note:

1. See 15-1248 (visit www.strem.com).

46-0955 Chloro[9,9-dimethyl-4,5-bis(diphenylphosphino)xanthene][2'-amino-1,1'-biphenyl] palladium(II) dichloromethane adduct, min. 98%

[1375325-77-1]

C₅₁H₄₂ClN₂O₂Pd; FW: 888.71; pale yellow powdr.



500mg
2g

Technical Note:

1. See 15-1242 (visit www.strem.com).

46-0360 *trans*-Dibromobis(triphenylphosphine)palladium(II), 99%

[22180-53-6]

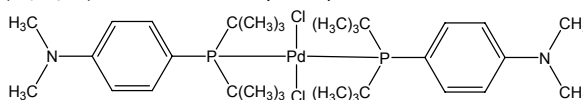
C₃₆H₃₀Br₂P₂Pd; yellow powdr.

1g
5g

46-0825 Dichlorobis{[4-(N,N-dimethylamino)phenyl]di-*t*-butylphosphino} palladium(II), min. 98% PdAMPHOS [887919-35-9]

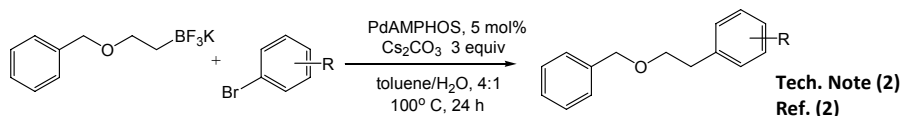
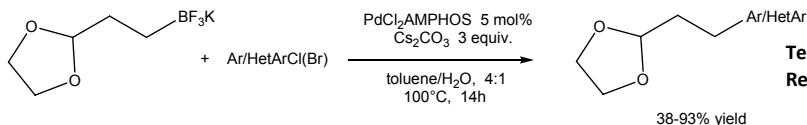
(C₁₆H₂₈NP)₂PdCl₂; FW: 708.07; yellow powdr.

250mg
1g
5g



Technical Notes:

1. Useful catalyst for the Suzuki Cross-Coupling of dioxolanylethyltrifluoroborate and aryl/heteroaryl chlorides.
2. Useful catalyst for the Suzuki Cross-Coupling of benzyloxyethyltrifluoroborate.



References:

1. *Org. Lett.*, **2013**, *15*, 1536.
2. *J. Org. Chem.*, **2012**, *77*, 10399.

PALLADIUM Compounds

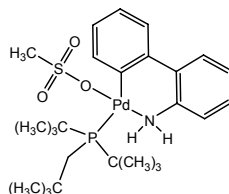
46-0358 Methanesulfonato(di-*t*-butylneopentyl-phosphino)(2'-amino-1,1'-biphenyl-2-yl) palladium(II), min. 98%

NEW→

 $C_{26}H_{42}NO_3PPdS$; FW: 586.08;

white to off-white powdr.

Note: Patents: PCT/US2013/030779, US Serial No. 13/799620

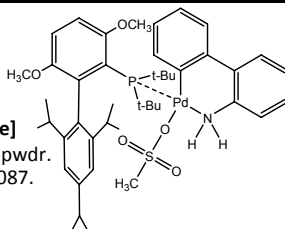
250mg
1g**46-0325** Methanesulfonato(2-(di-*t*-butylphosphino)-3,6-dimethoxy-2',4',6'-tri-*i*-propyl-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [t-butylBrettPhos Palladacycle]

NEW→

 $C_{44}H_{60}NO_3PPdS$; FW: 854.43; red-brown powdr.

Note: Patents: US 6,395,916, US 6,307,087.

Buchwald Palladacycle Precatalyst Kit 2 component see (page 12).

100mg
500mg
2g
10g

Technical Note:

1. See (page 16).

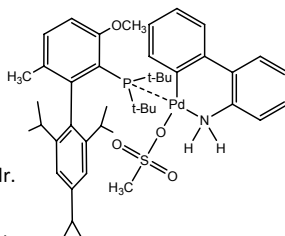
46-0335 Methanesulfonato(2-(di-*t*-butylphosphino)-3-methoxy-6-methyl-2',4',6'-tri-*i*-propyl-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl) palladium(II), min. 98% [RockPhos Palladacycle]

NEW→

 $C_{44}H_{62}NO_4PPdS$; FW: 838.43; brown powdr.

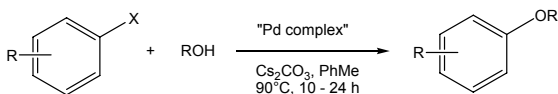
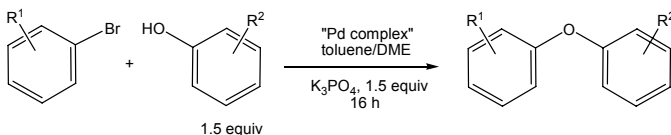
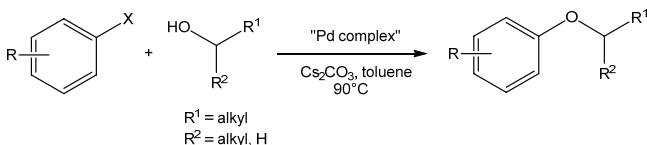
Note: Patents: PCT/US2013/030779,

US Serial No. 13/799620. Buchwald Palladacycle Precatalyst Kit 2 component. See (page 12).

100mg
500mg
2g
10g

Technical Notes:

1. Palladium precatalyst used for the arylation of an aliphatic alcohol.
2. Palladium precatalyst used for the synthesis of diaryl ethers under mild conditions.
3. Palladium precatalyst used for the intermolecular C-O bond formation with secondary and primary alcohols.

Tech. Note (1)
Ref. (1)Tech. Note (2)
Ref. (2)Tech. Note (2)
Ref. (3)

References:

1. *Org. Lett.*, **2013**, 15, 2876.
2. *Org. Lett.*, **2012**, 14, 170.
3. *Angew. Chem. Int. Ed.*, **2011**, 50, 9943.

PALLADIUM Compounds

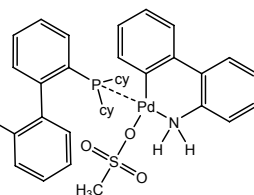
46-0237

NEW→

Methanesulfonato[2-(dicyclohexylphosphino)-2'-(N,N-dimethylamino)-1,1'-biphenyl](2'-amino-1,1'-biphenyl-2-yl)palladium(II) CH₂Cl₂ adduct, min. 98% [DavePhos Palladacycle] [1445085-87-9]

C₃₉H₄₉N₂O₃PPdS; FW: 763.28; white powdr.

Note: Patents: PCT/US2013/030779, US Serial No. 13/799620.



250mg
1g

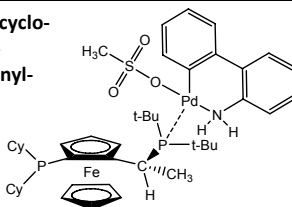
46-0353

NEW→

Methanesulfonato{(R)-(-)-1-[(S)-2-(dicyclohexylphosphino)ferrocenyl]ethyl}di-*t*-butylphosphine[2'-amino-1,1'-biphenyl-2-yl]palladium(II), min. 98%

C₄₅H₆₅FeNO₃P₂PdS; FW: 924.28; red-orange solid

Note: Patents: PCT/US2013/030779, US Serial No. 13/799620.



100mg
500mg

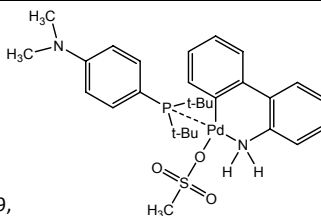
46-0345

NEW→

Methanesulfonato[[4-(N,N-dimethylamino)phenyl]di-*t*-butylphosphino][2'-amino-1,1'-biphenyl-2-yl]palladium(II), min. 98% [amphos Palladacycle]

C₂₉H₄₁N₂O₃PPdS; FW: 635.11; beige to tan powdr.

Note: Patents: PCT/US2013/030779, US Serial No. 13/799620.



250mg
1g

Technical Note:

1. See 15-1248 (visit www.strem.com).

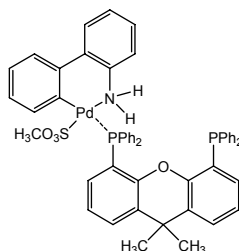
46-0957

NEW→

Methanesulfonato[9,9-dimethyl-4,5-bis(diphenylphosphino)xanthene][2'-amino-1,1'-biphenyl]palladium(II) dichloromethane adduct, min. 98% [1445085-97-1]

C₆₂H₄₅NO₄P₂PdS; FW: 948.35; pale yellow powdr.

Note: Patents: PCT/US2013/030779, US Serial No. 13/799620.



500mg
2g

Technical Note:

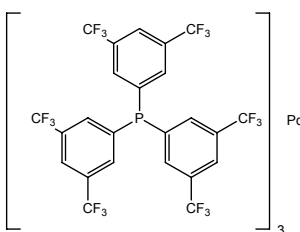
1. See 15-1242 (visit www.strem.com).

46-2185

NEW→

Tris{tris[3,5-bis(trifluoromethyl)phenyl]phosphine}palladium(0), 99% [1130784-80-3]

C₇₂H₂₇F₅₄P₃Pd; FW: 2117.24; yellow xtl. air sensitive, (store cold)



500mg
2g

PHOSPHORUS Compounds

96-2310

NEW→

SKP Ligand Kit for asymmetric-allylic amination and cyclopropanation
SEE KITS SECTION (page 80)

PHOSPHORUS Compounds

15-7125 **1,2-Bis[1,3-bis(2,6-di-*i*-propylphenyl)imidazol-2-ylidene]diphosphine, min. 95%**
NEW→ [1080030-13-2] $C_{54}H_{72}N_4P_2$; FW: 839.12; orange-red xtl.
air sensitive

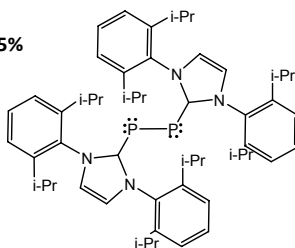
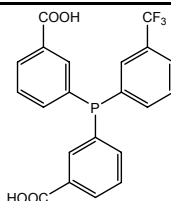
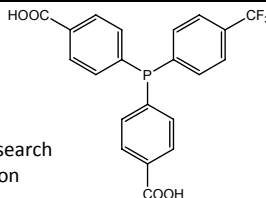
Note: Sold under license from the University of Georgia Research Foundation, Inc. for research purposes only. US Patent 8,278,456.

Technical Note:

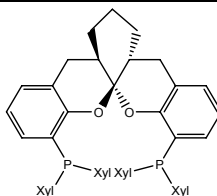
1. A carbene-stabilized diphosphorus.

References:

1. *Inorg. Chem.*, **2011**, *50*, 12326.
2. *J. Am. Chem. Soc.*, **2008**, *130*, 14970.

50mg
250mg**15-0270** **Bis(3-carboxyphenyl)(3-trifluoromethylphenyl)phosphine, min. 97%**
NEW→ **m-Miran2phos** $C_{21}H_{14}F_3O_4P$; FW: 418.30; white powdr.
Note: Sold under license from UAB for research purposes only. Spanish Patent Application P201231702.100mg
500mg**15-0268** **Bis(4-carboxyphenyl)(4-trifluoromethylphenyl)phosphine, min. 97%**
NEW→ **p-Miran2phos** $C_{21}H_{14}F_3O_4P$; FW: 418.30; white solid
Note: Sold under license from AB for research purposes only. Spanish Patent Application P201231702.100mg
500mg**15-4320** **(+)-1,13-Bis[di(3,5-dimethylphenyl)phosphino]-(5aR,8aR,14aR)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (R,R,R)-(+)-Xyl-SKP**
NEW→ [1429939-35-4] $C_{52}H_{54}O_2P_2$; FW: 772.93; white solid;
[α]_D +166° (c 1.00, CHCl₃); m.p. 102-103°
air sensitive

Note: Sold in collaboration with SIOC for research purposes only. Patents PCT/CN2013/071091, CN202110253896.5. SKP Ligand Kit component. See (page 80).

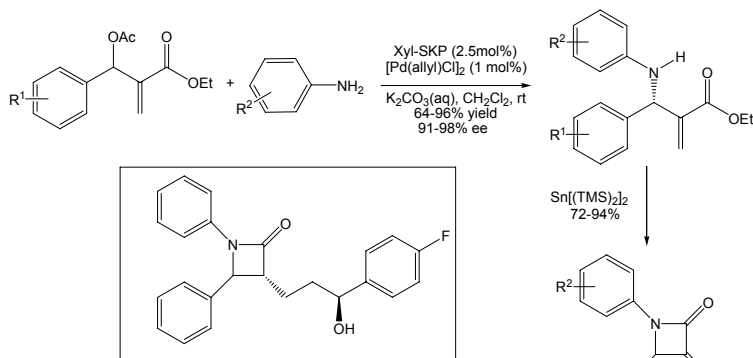
25mg
100mg

Technical Note:

1. Efficient ligand for the palladium-catalyzed, asymmetric allylic amination of racemic Morita-Baylis-Hillman adducts.
2. See 15-4311 (page 66).

PHOSPHORUS Compounds

15-4320 (+)-1,13-Bis[di(3,5-dimethylphenyl)phosphino]-(5aR,8aR,14aR)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (R,R,R)-(+)-Xyl-SKP
NEW→
 (cont.)

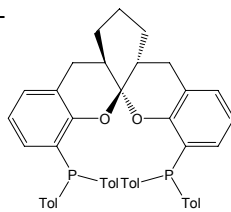


References:

1. *Angew. Chem. Int. Ed.*, **2012**, 51, 9276.
2. *Angew. Chem. Int. Ed.*, **2012**, 51, 936.

15-4321 (-)-1,13-Bis[di(3,5-dimethylphenyl)phosphino]-(5aS,8aS,14aS)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (S,S,S)-(-)-Xyl-SKP [1429939-31-0]
NEW→
 $C_{52}H_{54}O_2P_2$; FW: 772.93; white solid; $[\alpha]_D -166^\circ$ (c 1.00, $CHCl_3$); m.p. 102-103° *air sensitive*
 Note: Sold in collaboration with SIOC for research purposes only. Patents PCT/CN2013/071091, CN202110253896.5. SKP Ligand Kit component. See (page 80).
 Technical Note:
 1. See 15-4320 (page 64).

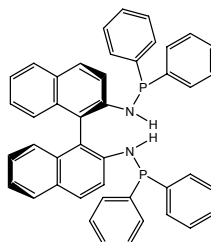
15-4330 (+)-1,13-Bis[di(4-methylphenyl)phosphino]-(5aR,8aR,14aR)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (R,R,R)-(+)-Tol-SKP [1429939-32-1]
NEW→
 $C_{48}H_{46}O_2P_2$; FW: 716.83; white solid; $[\alpha]_D +118^\circ$ (c 1.00, $CHCl_3$); m.p. 90-92° *air sensitive*
 Note: Sold in collaboration with SIOC for research purposes only. Patents PCT/CN2013/071091, CN202110253896.5. SKP Ligand Kit component. See (page 80).
 Technical Note:
 1. See 15-4311 (page 66).



15-4331 (-)-1,13-Bis[di(4-methylphenyl)phosphino]-(5aS,8aS,14aS)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (S,S,S)-(-)-Tol-SKP
NEW→
 $C_{48}H_{46}O_2P_2$; FW: 716.83; white powdr.; $[\alpha]_D -118^\circ$ (c 1.00, $CHCl_3$); m.p. 90-92° *air sensitive*
 Note: Sold in collaboration with SIOC for research purposes only. Patents PCT/CN2013/071091, CN202110253896.5. SKP Ligand Kit component. See (page 80).
 Technical Note:
 1. See 15-4311 (page 66).

PHOSPHORUS (Compounds)

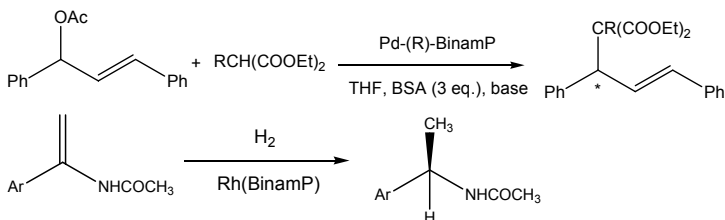
15-0535 (R)-2,2'-Bis(diphenylphosphinoamino)-1,1-binaphthyl (R)-BinamP [74974-14-4]
NEW→ C₄₄H₃₄N₂P₂; FW: 652.70; white powdr.
 Note: Sold in collaboration with JM for research purposes only.



100mg
500mg

Technical Notes:

1. Chiral ligand used for the palladium-catalyzed, asymmetric allylic alkylation.
2. Chiral ligand used for the rhodium-catalyzed, hydrogenation of aryl-enamides.



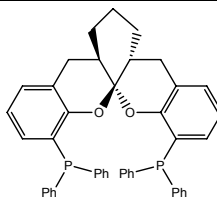
Tech. Note (1)
Ref. (1)

Tech. Note (1)
Ref. (1)

References:

1. *Tetrahedron Asymm.*, **2004**, 15(2), 213.
2. *J. Am. Chem. Soc.*, **1998**, 120, 5808.

15-4310 (+)-1,13-Bis(diphenyl)phosphino-(5aR,8aR,14aR)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano [3,2-d]xanthene, 97%
NEW→ (R,R,R)-(+)-Ph-SKP [1360823-43-3]
 C₄₄H₃₈O₂P₂; FW: 660.72; white solid; [α]_D +113° (c 1.00, CHCl₃); m.p. 101-103°
air sensitive



25mg
100mg

Note: Sold in collaboration with SIOC for research purposes only. Patents PCT/CN2013/071091, CN202110253896.5. SKP Ligand Kit component. See (page 80).

Technical Notes:

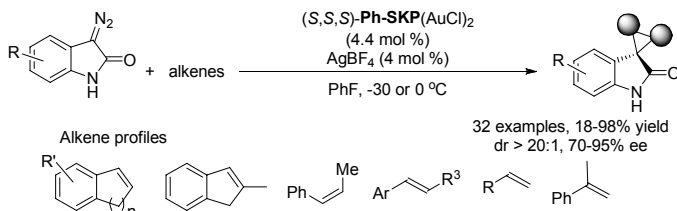
1. See 15-4311 (page 66).

15-4311 (-)-1,13-Bis(diphenyl)phosphino-(5aS,8aS,14aS)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano [3,2-d]xanthene, 97%
NEW→ (S,S,S)-(-)-Ph-SKP [1439556-82-7]
 C₄₄H₃₈O₂P₂; FW: 660.72; white solid; [α]_D -113° (c 1.00, CHCl₃); m.p. 101-103° *air sensitive*

Note: Sold in collaboration with SIOC for research purposes only. Patents PCT/CN2013/071091, CN202110253896.5. SKP Ligand Kit component. See (page 80).

Technical Notes:

1. Efficient ligand for the Au(I)-catalyzed, highly stereoselective, olefin cyclopropanation of diazooxindoles.
2. See 15-4320 (page 64).



32 examples, 18-98% yield
dr > 20:1, 70-95% ee

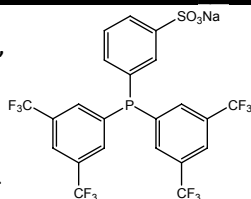
Tech. Note (1)
Ref. (1)

References:

1. *J. Am. Chem. Soc.*, **2013**, 135, 8197.
2. *Angew. Chem. Int. Ed.*, **2012**, 51, 936.

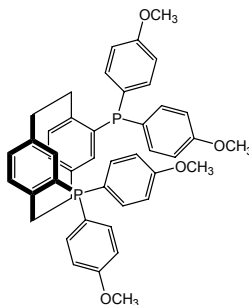
PHOSPHORUS Compounds

15-0572 **Bis(3,5-di-trifluoromethylphenyl)**
(3-sulfonatophenyl)phosphine, sodium salt,
min. 97% DAN2PHOS [1289463-91-7]
 $C_{22}H_{10}F_{12}NaO_3PS$; FW: 636.32;
 white solid
 Note: Sold under license from UAB for
 research purposes only. PCT/EP2010/06553.



100mg
 500mg

15-0710 **(R)-4,12-Bis(4-methoxyphenyl)-[2.2]-**
paracyclophane R-An-Phanephos
 [364732-86-5]
 $C_{44}H_{42}O_4P$; FW: 696.75; white powdr.
 Note: Sold in collaboration with JM for
 research purposes only.



100mg
 500mg

Technical Note:

1. See 15-0425 (visit www.strem.com).

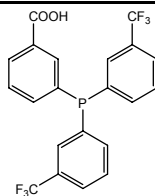
15-0711 **(S)-4,12-Bis(4-methoxyphenyl)-[2.2]-paracyclophane**
S-An-Phanephos
 $C_{44}H_{42}O_4P$; FW: 696.75; white powdr.
 Note: Sold in collaboration with JM for research purposes only.

100mg
 500mg

Technical Note:

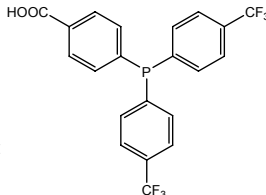
1. See 15-0426 (visit www.strem.com).

15-0265 **Bis(3-trifluoromethylphenyl)**
(3-carboxyphenyl)phosphine, min. 97%
m-Miranphos
 $C_{21}H_{13}F_6O_2P$; FW: 442.29; white solid
 Note: Sold under license from UAB for
 research purposes only. Spanish Patent
 Application P201231702.



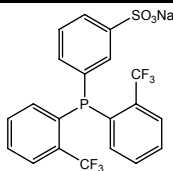
100mg
 500mg

15-0260 **Bis(4-trifluoromethylphenyl)**
(4-carboxyphenyl)phosphine,
min. 97% p-Miranphos
 $C_{21}H_{13}F_6O_2P$; FW: 442.29; white powdr.
 Note: Sold under license from UAB for
 research purposes only. Spanish Patent
 Application P201231702.



100mg
 500mg

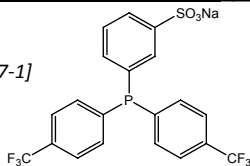
15-0579 **Bis(2-trifluoromethylphenyl)**
(3-sulfonatophenyl)phosphine, sodium salt,
min. 97% o-DAN2PHOS [1289463-93-9]
 $C_{20}H_{12}F_6NaO_3PS$; FW: 500.33;
 white powdr.
 Note: Sold under license from UAB for
 research purposes only.
 PCT/EP2010/065531.



100mg
 500mg

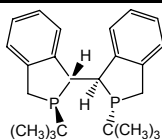
PHOSPHORUS Compounds

15-0582 **Bis(4-trifluoromethylphenyl)**
(3-sulfonatophenyl)phosphine, sodium
salt, min. 97% p-DAN2PHOS [1289463-87-1]
 $C_{20}H_{12}F_6NaO_3PS$; FW: 500.33; white powdr.
 Note: Sold under license from UAB for
 research purposes only.
 PCT/EP2010/065531.



100mg
 500mg

15-1060 **(1R,1'R,2S,2'S)-(+)-2,2'-Di-t-butyl-**
2,3,2',3'-tetrahydro-1,1'-bi-1H-iso-
phosphindole, min. 98%
(R,R,S,S)-DUANPHOS [528814-26-8]
 $C_{24}H_{32}P_2$; FW: 382.46; white xtl.; $[\alpha]_D^{25} +19.5$
air sensitive

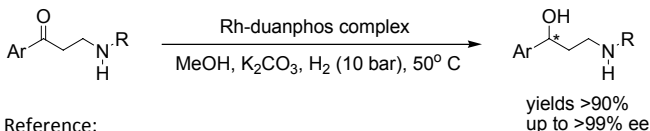


100mg
 500mg

Note: Sold in collaboration with Chiral Quest for research
 purposes only. Patent pending, PCT/US02/35788. Chiral Quest
 Catalyst and Ligand Toolbox Kit component. Visit www.strem.com.

Technical Note:

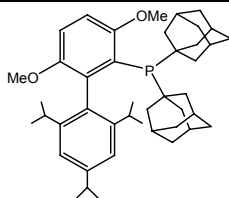
- As a highly electron-donating and conformationally rigid ligand, the rhodium complex of DuanPhos has exhibited remarkably high enantioselectivities and reactivities for the hydrogenation of a variety of functionalized olefins.



Reference:

- Angew. Chem. Int. Ed.*, **2005**, 44, 1687.

15-1138 **2-(Di-1-adamantylphosphino)-**
3,6-dimethoxy-2',4',6'-tri-i-propyl-
1,1'-biphenyl, min. 95% AdBrettPhos
 [1160861-59-5]

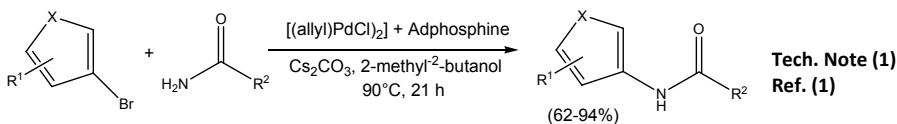


100mg
 500mg
 2g

$C_{43}H_{61}O_2P_2$; FW: 640.92;
 off-white to pale yellow powdr.
 Note: Buchwald Biaryl Phosphine Ligand
 Master Kit component. See (page 10).
 Buchwald Biaryl Phosphine Ligand Mini Kit 1 component.
 See (page 10). Patents: US 6,395,916, US 6,307,087.

Technical Note:

- Ligand used in the palladium-catalyzed amidation of five-membered heterocycles as electrophiles.



Tech. Note (1)
Ref. (1)

Reference:

- J. Am. Chem. Soc.*, **2012**, 134, 19922.

15-1093 **Di-t-butylphenylphosphine, min. 98% (50wt% in toluene)**
[32673-25-9]
 $C_{14}H_{23}P$; FW: 227.31; colorless liq.
air sensitive

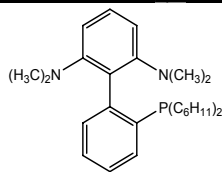
2g
 10g

15-1100 **Dicyclohexylphenylphosphine, min. 95%** [6476-37-5]
 $(C_6H_{11})_2(C_6H_5)P$; FW: 274.38; white solid
air sensitive

1g
 5g

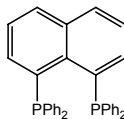
PHOSPHORUS Compounds

15-1147 **2-Dicyclohexylphosphino-2',6'-dimethylamino-1,1'-biphenyl, min. 98% CPhos** [1160556-64-8]
 $C_{28}H_{41}N_2P$; FW: 436.61; yellow-orange xtl.; m.p. 111-113°
 Note: Patents: US 6,395,916, US 6,307,087



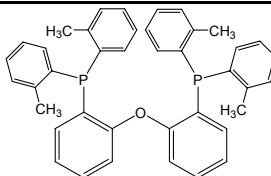
1g
5g

15-7123 **1,8-(Diphenylphosphino)naphthalene, 99%**
 [153725-04-3]
 $C_{34}H_{26}P_2$; FW: 496.52; yellow xtl.



250mg
1g

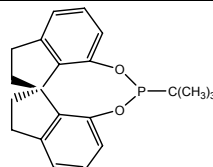
15-7365 **2,2'-(Di-o-tolylphosphino)diphenylether, min. 97% DTP-DPEphos** [205497-64-9]
 $C_{40}H_{36}OP_2$; FW: 594.66; white powdr.



250mg
1g

Technical Note: DPEphos analog.

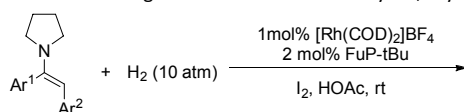
15-5130 **(11aR)-(+)-10,11,12,13-Tetrahydro-5-(1,1-dimethylethyl)diinden[7,1-de,1',7'-fg][1.3.2] dioxaphosphocin, 97% (R)-FuP-tBu**
 $C_{21}H_{23}O_2P$; FW: 338.38; white solid; $[\alpha]_D^{25} +456^\circ$ (c 1.2, CH_2Cl_2)
moisture sensitive



25mg
100mg

Technical Note:

1. Chiral ligand for the rhodium-catalyzed, asymmetric hydrogenation of enamines.



Reference:

1. *J. Am. Chem. Soc.*, **2006**, *128*, 11774.

100 conv.
73 - 99.9% ee

Tech. Note (1)
Ref. (1)

15-5131 **(11aS)-(-)-10,11,12,13-Tetrahydro-5-(1,1-dimethylethyl)diinden[7,1-de,1',7'-fg][1.3.2] dioxaphosphocin, 97% (S)-FuP-tBu**
 [912457-08-0]
 $C_{21}H_{23}O_2P$; FW: 338.38; white solid; $[\alpha]_D^{25} -456^\circ$ (c 1.2, CH_2Cl_2)
moisture sensitive

25mg
100mg

Technical Note:

1. See 15-5130 (page 69).

15-5818 **Tri-*t*-butylphosphine, min. 98% (50wt% in toluene)** [13716-12-6]
 $C_{12}H_{27}P$; FW: 202.32; colorless liq. *air sensitive*

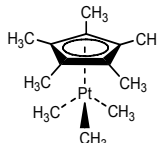
2g
10g

PLATINUM Compounds

98-4026 **(Trimethyl)methylcyclopentadienylplatinum(IV), 99%, 78-1350, contained in 50 ml Swagelok® cylinder high temperature valve (96-1071) for CVD/ALD** [94442-22-5]
 $(CH_3)_3(CH_3C_5H_4)Pt$; FW: 319.32; off-white powdr.; m.p. 30-31°; b.p. subl. 23°/0.053mm; d. 1.88 *air sensitive, (store cold)*

20g

78-1358 **(Trimethyl)pentamethylcyclopentadienylplatinum(IV), 99%** [97262-98-1]
 $C_{13}H_{24}Pt$; FW: 375.41; off-white powdr.
air sensitive



250mg
1g
5g

POTASSIUM Compounds

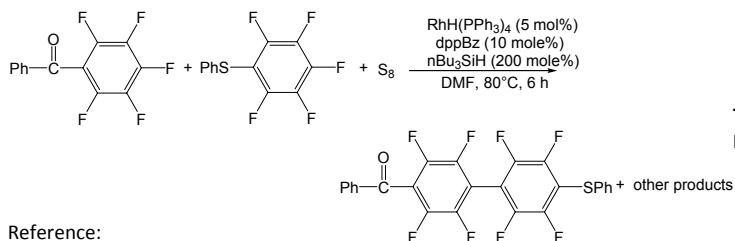
19-3025	Potassium dicyanocuprate [13967-50-5]	10g
NEW→	KCu(CN) ₂ ; FW: 154.68; white powdr.	50g
HAZ		
19-1935	Potassium graphite KC ₈ [12081-88-8]	1g
NEW→	C ₈ K; FW: 135.18; bronze solid	5g
amp	air sensitive, moisture sensitive	
HAZ		

RHODIUM Compounds

45-0915	Hydridotetrakis(triphenylphosphine)rhodium(I), 99%	250mg
NEW→	[18284-36-1]	1g
	RhH[P(C ₆ H ₅) ₃] ₄ ; FW: 1153.06; yellow microxtl.	

Technical Note:

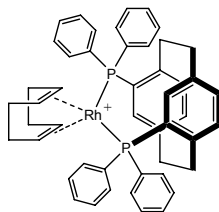
- Starting material for the preparation of a rhodium/phosphine complex used in the synthesis of diarylsulfides from aryl fluorides and sulfur/organopolysulfides.



Reference:

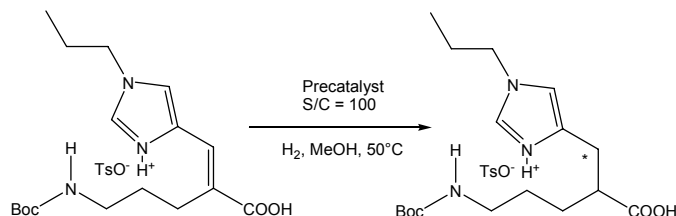
- Org. Lett.*, **2012**, *14*, 5318.

45-0217	(R)-(-)-4,12-Bis(diphenylphosphino)	100mg
NEW→	[2.2]paracyclophane(1,5-cyclooctadiene)	500mg
	rhodium(I) tetrafluoroborate, min. 97%	
	[849950-56-7]	
	C ₄₈ H ₄₆ BF ₄ P ₂ Rh; FW: 874.54;	
	yellow-orange solid	
	air sensitive	
	Note: Sold in collaboration with JM for research purposes only.	



Technical Note:

- Catalyst use in the asymmetric synthesis of an imidazole-substituted delta-amino acid.



Reference:

- Org. Lett.*, **2005**, *7*, 1931.

RHODIUM Compounds

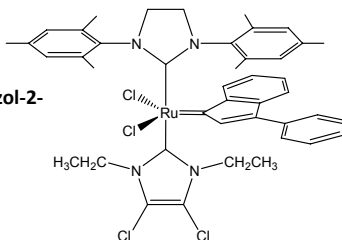
- 45-0218** (S)-(+)-4,12-Bis(diphenylphosphino)[2.2]paracyclophane
NEW→ (1,5-cyclooctadiene)rhodium(I) tetrafluoroborate, min. 97%
 [200808-73-7]
 $C_{48}H_{46}BF_4P_2Rh$; FW: 874.54
air sensitive
 Note: Sold in collaboration with JM for research purposes only.

Technical Note:

- See 45-0217 (page 70).

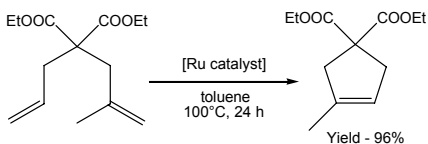
RUTHENIUM Compounds

- 44-0026** 1,3-Bis(2,4,6-trimethylphenyl)-2-imidazolidinylidene(3-phenyl-1H-inden-1-ylidene)(4,5-dichloro-1,3-diethyl-1,3-dihydro-2H-imidazol-2-ylidene)ruthenium(II) chloride
NEW→ [1228169-92-3]
 $C_{43}H_{46}Cl_4N_4Ru$; FW: 861.73;
 orange-brown solid

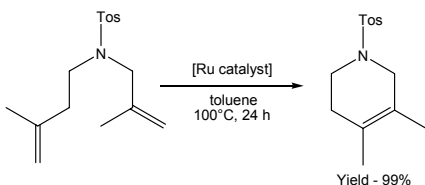


Technical Note:

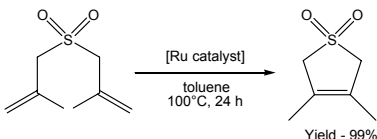
- Catalyst used for RCM reactions leading to tetrasubstituted olefins.



Tech. Note (1)
Ref. (1)



Tech. Note (1)
Ref. (1)

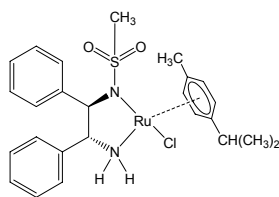


Tech. Note (1)
Ref. (1)

Reference:

- Organometallics*, **2010**, *29*, 2761.

- 44-2319** Chloro(p-cymene)[(1R,2R)-(-)-2-amino-1,2-diphenylethyl(methylsulfonylamido)]ruthenium(II) $RuCl(p\text{-cymene})[(R,R)\text{-MsDpen}]$
NEW→ [1097730-63-6]
 $C_{25}H_{31}ClN_2O_2RuS$; FW: 560.10;
 yellow-orange solid
air sensitive
 Note: Sold in collaboration with JM for research purposes only.



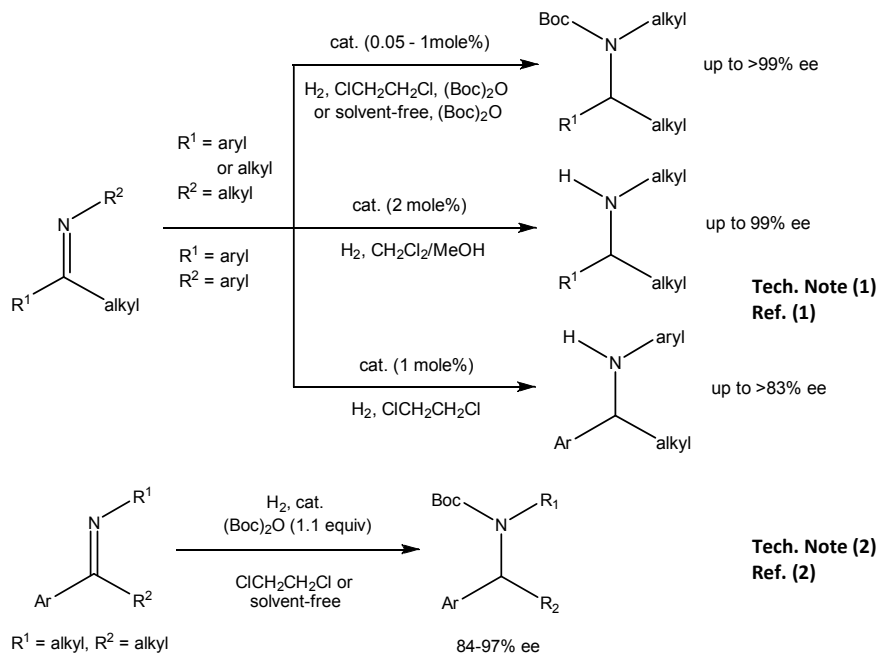
250mg
 1g

RUTHENIUM Compounds

44-2319 Chloro(p-cymene)[(1R,2R)-(-)-2-amino-1,2-diphenylethyl(methylsulfonylamido)]
 ruthenium(II) RuCl(p-cymene)[(R,R)-MsDpen] [1097730-63-6]
 (cont.)

Technical Notes:

1. Catalyst used in the asymmetric hydrogenation of N-alkyl and N-ketimines.
2. Catalyst used in the asymmetric hydrogenation of N-alkyl ketimines.



References:

1. *Tetrahedron*, **2012**, 68(26), 5248.
2. *Chem. Eur. J.*, **2011**, 17(4), 1109.

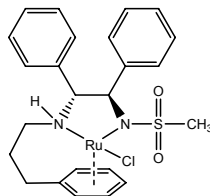
44-2320 Chloro(p-cymene)[(1S,2S)-(-)-2-amino-1,2-diphenylethyl
 ((methylsulfonylamido)]ruthenium(II)
 RuCl(p-cymene) [(S,S)-MsDpen] [329371-25-7]
 $C_{25}H_{31}ClN_2O_2RuS$; FW: 560.10; orange solid *air sensitive*
 Note: Sold in collaboration with JM for research purposes only.

250mg
 1g

Technical Note:

1. See 44-2319 (page 71).

44-3020 Chloro{(1R,2R)-1,2-diphenyl-1-
 [(3-(η -6-phenyl)propyl)amino]-2-
 (methylsulfonylamido)}ruthenium(II)
 RuCl[(R,R)-teth-MsDpen]
 [1245811-39-5]
 $C_{12}H_{19}ClN_2O_2RuS$; FW: 391.88; brown powdr.
air sensitive
 Note: Sold in collaboration with JM for
 research purposes only.



100mg
 500mg

Technical Note:

1. See 44-0111 (page 76).

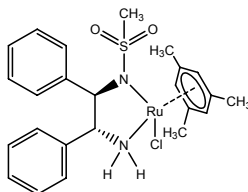
RUTHENIUM Compounds

- 44-3021** **Chloro[(1S,2S)-1,2-diphenyl-1-[(3-(η 6-phenyl)propyl)amino]-2-(methylsulfonylamido)]ruthenium(II)** 100mg
NEW→ **RuCl[(S,S)-teth-MsDpen]** [1245811-39-5] 500mg
 $C_{12}H_{19}ClN_2O_2RuS$; FW: 391.88; brown powdr. *air sensitive*
 Note: Sold in collaboration with JM for research purposes only.

Technical Note:

1. See 44-0111 (page 76).

- 44-2325** **Chloro(mesitylene)[(1R,2R)-(-)-2-amino-1,2-diphenylethyl(methylsulfonylamido)]ruthenium(II)** 250mg
NEW→ **RuCl(mesitylene)[(R,R)-MsDpen]**
 [1160707-20-9] 1g
 $C_{24}H_{29}ClN_2O_2RuS$; FW: 546.10;
 brown powdr. *air sensitive*
 Note: Sold in collaboration with JM for research purposes only.



Technical Note:

1. Catalyst used for producing optically active aliphatic fluoroalcohols.

Reference:

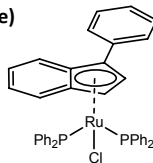
1. *Eur. Pat. Appl.*, **2011** EP2399895 A2 20111228.

- 44-2326** **Chloro(mesitylene)[(1S,2S)-(+)-2-amino-1,2-diphenylethyl(methylsulfonylamido)]ruthenium(II)** 250mg
NEW→ **RuCl(mesitylene)[(S,S)-MsDpen]** [865488-44-4] 1g
 $C_{24}H_{29}ClN_2O_2RuS$; FW: 546.10; brown powdr. *air sensitive*
 Note: Sold in collaboration with JM for research purposes only.

Technical Note:

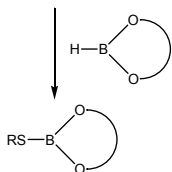
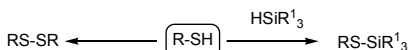
1. See 44-2325 (page 73).

- 44-0138** **Chloro(3-phenylindenyl)bis(triphenyl-phosphine)ruthenium(II), min. 98%** 250mg
NEW→ [1360949-97-8] 1g
 $C_{51}H_{41}ClP_2Ru$; FW: 852.34; red-brown solid

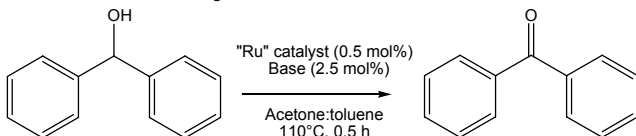


Technical Notes:

1. Efficient, ruthenium-catalyzed S-S, S-Si, and S-B bond forming reactions.
2. Chemoselective oxidation of secondary alcohols to ketones.
3. Ruthenium complex used as an efficient transfer hydrogenation catalyst.
4. Catalyst for the racemization of chiral alcohols.



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

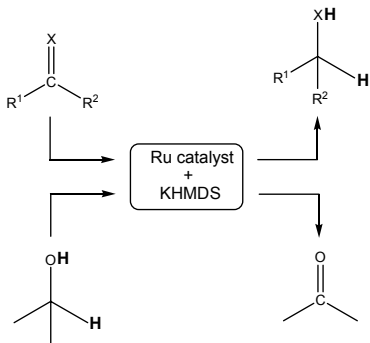
RUTHENIUM Compounds

44-0138 Chloro(3-phenylindenyl)bis(triphenyl-phosphine)ruthenium(II), min. 98%

NEW→

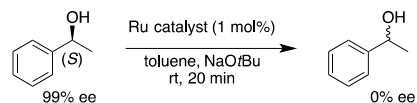
[1360949-97-8]

(cont.)



Tech. Note (3)

Ref. (3)



Tech. Note (4)

Ref. (4)

References:

1. *Chemical Communications*, **2013**, 49, 5829.
2. *Organometallics*, **2013**, 32, 660.
3. *Adv. Synth. Catal.*, **2012**, 354, 3036.
4. *Angew. Chem. Int. Ed.*, **2012**, 51, 1042.

44-2310 Dichloro[1,1'-bis(diphenylphosphino)ferrocene][(2-aminomethylpyridine)ruthenium(II) RuCl₂(AMPY)(DPPF)

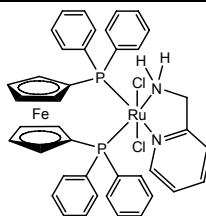
NEW→

[1287255-62-2]

C₄₀H₃₆Cl₂FeN₂P₂Ru; FW: 834.49;

yellow powdr. *air sensitive*

Note: Sold in collaboration with JM for research purposes only.

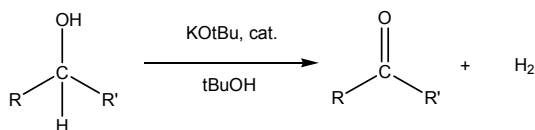


250mg

1g

Technical Note:

1. Efficient catalyst used in the dehydrogenation of alcohols to ketones.



Tech. Note (1)

Ref. (1)

Reference:

1. *Chem. Eur. J.*, **2011**, 17(12), 3474.

44-2314 Dichloro[(R)-(+)-2,2'-bis(di-p-tolylphosphino)-1,1'-binaphthyl][(2-aminomethylpyridine)ruthenium(II) RuCl₂(AMPY)[(R)Tol-Binap]

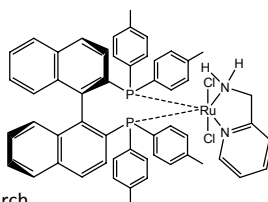
NEW→

[858116-31-1]

C₅₄H₄₈Cl₂N₂P₂Ru; FW: 958.89;

yellow powdr. *air sensitive*

Note: Sold in collaboration with JM for research purposes only.



250mg

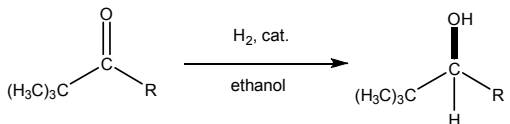
1g

Technical Note:

1. Efficient catalyst used in the asymmetric hydrogenation of tert-alkyl ketones.

RUTHENIUM Compounds

- 44-2314** Dichloro[(R)-(+)-2,2'-bis(di-p-tolylphosphino)-1,1'-binaphthyl](2-amino-methylpyridine) ruthenium(II) $\text{RuCl}_2(\text{AMPY})[(\text{R})\text{Tol-Binap}]$ [858116-31-1]
NEW→
 (cont.)



Tech. Note (1)
Ref. (1)

up to 100,000 TON
 up to 98% ee

Reference:

1. *J. Am. Chem. Soc.*, **2005**, 127(23), 8288.

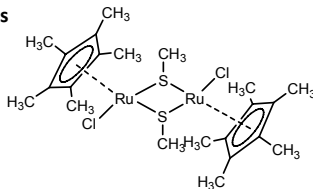
- 44-2315** Dichloro[(S)-(-)-2,2'-bis(di-p-tolylphosphino)-1,1'-binaphthyl] (2-aminomethylpyridine)ruthenium(II) $\text{RuCl}_2(\text{AMPY})[(\text{S})\text{-Tol-Binap}]$ [857678-55-8]
NEW→
 $\text{C}_{54}\text{H}_{48}\text{Cl}_2\text{N}_2\text{P}_2\text{Ru}$; FW: 958.89; yellow powd.
air sensitive
 Note: Sold in collaboration with JM for research purposes only.

250mg
 1g

Technical Note:

1. See 44-2314 (page 74).

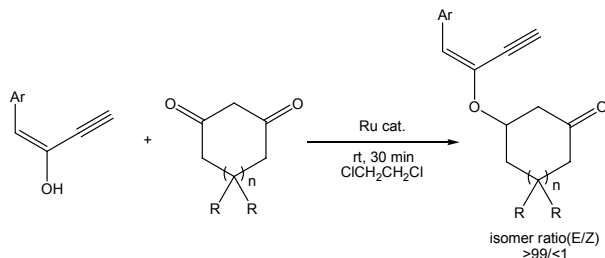
- 44-0645** Dichlorobis(μ-methanethioato)bis(pentamethylcyclopentadienyl)diruthenium(III), 99% (minimum 90% syn isomer) [216064-20-9]
NEW→
 $\text{C}_{22}\text{H}_{36}\text{Cl}_2\text{Ru}_2\text{S}_2$; black xtl.



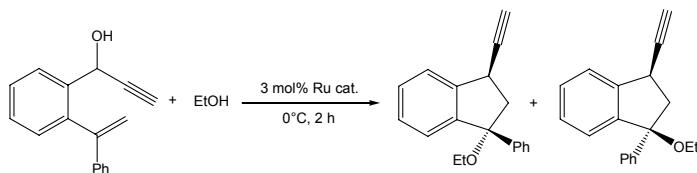
100mg
 500mg
 2g

Technical Notes:

1. Ruthenium-catalyzed vinylic substitution reactions.
2. Ruthenium-catalyzed oxypropargylation of alkenes.



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

References:

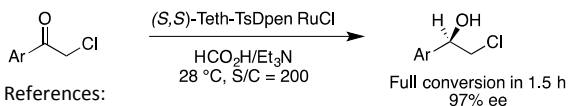
1. *J. Am. Chem. Soc.*, **2008**, 130, 2908.
2. *Organometallics*, **2009**, 28, 48.

RUTHENIUM Compounds

- 44-0111** {N-[3-(η 6-phenyl)propyl]-[(1R-2R)-1,2-diphenyl-1-4-methyl-benzenesulfonylamidato(kN')-ethyl-2-amino-(kN)]}ruthenium(II) 100mg
NEW→ (R,R)-Teth-TsDpen RuCl [1192620-83-9] 500mg
 $C_{30}H_{31}ClN_2O_2RuS$; FW: 620.17; orange powdr. *air sensitive*
 Note: Sold in collaboration with JM for research purposes only.

Technical Note:

1. Catalyst used for asymmetric α -transfer hydrogenation.



Tech. Note (1)
Ref. (1)

References:

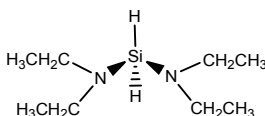
1. *J. Org. Chem.*, **2006**, 71, 7035.
 2. *Adv. Synth. Catal.*, **2012**, 354, 2545.

SCANDIUM Compounds

- 21-2023** Scandium trifluoromethanesulfonimide, min. 97% [176726-07-1] 250mg
NEW→ $Sc(C_2F_6NO_4S_2)_3$; FW: 885.40; white powdr. 1g
hygroscopic

SILICON Compounds

- 14-7030** Bis(diethylamino)silane, 97% 1g
NEW→ [27804-64-4] 5g
 HAZ $SiH_2[N(CH_2CH_3)_2]_2$; FW: 174.36;
 NO UPS colorless liq.; b.p. 70° (30mm);
 d. 0.804
air sensitive, moisture sensitive



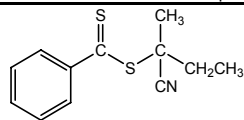
SODIUM Compounds

- 11-1450** Sodium hexafluoroacetylacetonate, 97% [22466-49-5] 1g
NEW→ $Na(CF_3COCH_2COCF_3)_3$; FW: 230.04; white powdr. 5g
hygroscopic 25g

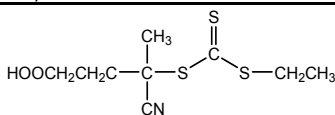
SULFUR Compounds

RAFT AGENTS – Limited Quantities Available

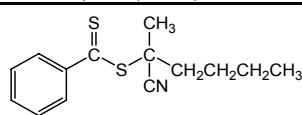
Note: Sold for research purposes only. Not for use in humans or animals. Patents: WO98/01478, WO99/311444.



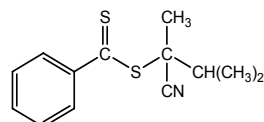
16-0517



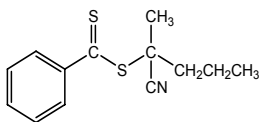
16-0417



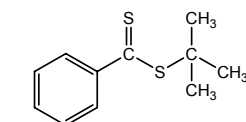
16-0516



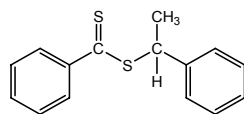
16-0528



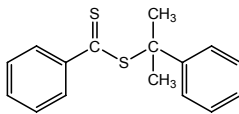
16-0523



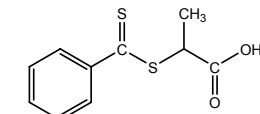
16-0521



16-0526



16-0513



16-0532

SULFUR Compounds

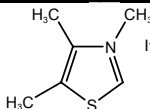
RAFT AGENTS – Limited Quantities Available

Note: Sold for research purposes only. Not for use in humans or animals. Patents: WO98/01478, WO99/311444.

16-0517 NEW→	2-Cyano-2-butylbenzodithiolate [220182-83-2] $C_{12}H_{13}NS_2$; FW: 235.37; dark red liq. <i>light sensitive, (store cold)</i>	100mg
16-0417 NEW→	4-Cyano-4-[(ethylsulfanylthiocarbonyl)sulfanyl]pentanoic acid, min. 97% [1137725-46-2] $C_9H_{13}NO_2S_3$; FW: 263.40; yellow-orange powder. <i>light sensitive, (store cold)</i>	250mg 1g
16-0516 NEW→	2-Cyano-2-hexylbenzodithiolate $C_{14}H_{17}NS_2$; FW: 263.42; dark red liq. <i>light sensitive, (store cold)</i>	100mg
16-0528 NEW→	2-Cyano-3-methyl-2-butylbenzodithiolate $C_{13}H_{15}NS_2$; FW: 249.40; dark red liq. <i>light sensitive, (store cold)</i>	100mg
16-0523 NEW→	2-Cyano-2-pentylbenzodithiolate $C_{13}H_{15}NS_2$; FW: 249.40; dark red liq. <i>light sensitive, (store cold)</i>	100mg
16-0521 NEW→	2-Methyl-2-propylbenzodithiolate [5925-55-3] $C_{11}H_{14}S_2$; FW: 210.36; red-orange liq. <i>light sensitive, (store cold)</i>	100mg
16-0526 NEW→	2-Phenylethylbenzodithiolate [37912-25-7] $C_{15}H_{14}S_2$; FW: 258.40; red-orange liq. <i>light sensitive, (store cold)</i>	100mg
16-0513 NEW→	2-Phenyl-2-propylbenzodithiolate, min. 97% [201611-77-0] $C_{16}H_{16}S_2$; FW: 272.43; dark red-purple liq. <i>light sensitive, (store cold)</i>	250mg
16-0532 NEW→	2-(Thiobenzoylthio)propionic acid, min. 97% [78751-36-7] $C_{10}H_{10}O_2S_2$; FW: 226.32 <i>light sensitive, (store cold)</i>	100mg 500mg

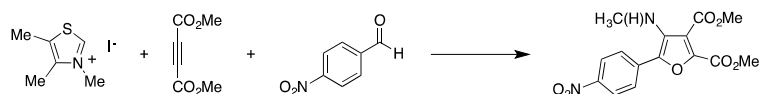
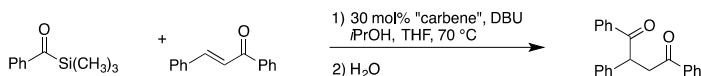
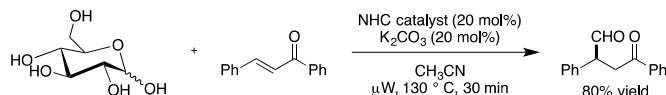
SULFUR Compounds

16-2230 NEW→	3,4,5-Trimethylthiazolium iodide, 99% [62993-85-5] $C_6H_{10}INS$; FW: 255.12; white solid <i>moisture sensitive</i>	1g 5g
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Technical Notes:

1. Reagent used for the synthesis of highly substituted 3-aminofurans.
2. Thiazolium-catalyzed additions of acylsilanes.
3. N-heterocyclic carbene catalyzed C–C bond cleavage of carbohydrates to generate acylanions for a Stetter reaction.

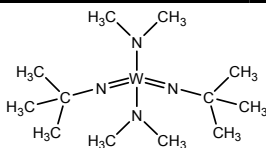
Tech. Note (1)
Ref. (1)Tech. Note (2)
Ref. (2)Tech. Note (3)
Ref. (3)

References:

1. *J. Org. Chem.*, **2005**, *70*, 8919.
2. *J. Org. Chem.*, **2006**, *71*, 5715.
3. *J. Am. Chem. Soc.*, **2013**, *135*, 8113.

TUNGSTEN Compounds

74-1225 **Bis(t-butylimido)bis(dimethylamido) tungsten(VI), min. 97% BTBMW** [406462-43-9]
NEW→ $C_{12}H_{30}N_4W$; FW: 414.23; yellow liq.;
 b.p. 81°C (0.02mm); d. 1.305
air sensitive, moisture sensitive



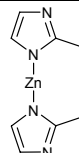
1g
5g

ZINC Compounds

30-3095 **Zinc i-propoxide, 99%** [13282-39-8]
NEW→ $Zn(OC_3H_7)_2$; FW: 183.56; white powdr.
moisture sensitive

1g
5g

30-4015 **Zinc 2-methylimidazole MOF (ZIF-8)** [59061-53-9]
NEW→ $C_8H_{10}N_4Zn$; FW: 227.58; white solid
 HAZ



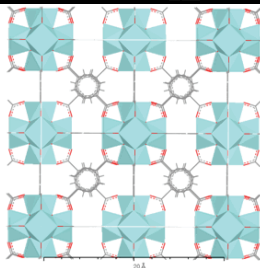
1g
5g
25g

Technical Notes:

- Use of ZIF-8 in the separation of alkanes, alkenes and aromatics.
 - Separation of xylene isomers.
Micropor. Mesopor. Mat., **2013**, 173, 1.
 - Separation of C6 Paraffins.
Ind. Eng. Chem. Res., **2012**, 51, 4692.
 - Effective separation of propylene/propane binary mixtures.
J. Membrane Sci., **2012**, 390-391, 93.
- Use of ZIF-8 as a catalyst and catalyst-support.
 - Catalytic activity of ZIF-8 in the synthesis of styrene carbonate.
Chem. Commun., **2013**, 32, 36.
 - Iridium nanoparticles stabilized by metal organic frameworks: synthesis, structural properties and catalytic performance.
Dalton Trans., **2012**, 41, 12690.
 - Zeolitic imidazole frameworks: Catalysts in the conversion of carbon dioxide to chloropropene carbonate.
ACS Catalysis, **2012**, 2, 180.
 - Expanding applications of metal-organic frameworks: zeolite imidazolate framework ZIF-8 as an efficient heterogeneous catalyst for the Knoevenagel reaction.
ACS Catalysis, **2011**, 1, 120.
- Use of ZIF-8 in gas purification.
 - MOF-containing mixed-matrix membranes for CO₂/CH₄ and CO₂/N₂ binary gas mixture separations.
Sep. Purif. Technol., **2011**, 81, 31.
 - Porous polyethersulfone-supported Zeolitic Imidazolate Framework Membranes for hydrogen separation.
J. Phys.Chem. C., **2012**, 116, 13264.

ZIRCONIUM Compounds

40-1105 **Zirconium 1,4-dicarboxybenzene MOF (UiO-66)** [1072413-80-9]
NEW→ $Zr_6O_4(OH)_4(C_8H_6O_4)_6$; white powdr.
 Note: Sold under license from Inven2 AS for research purposes only.
 EP 09738396 and US 12/989,641.



500mg
2g

Technical Note:

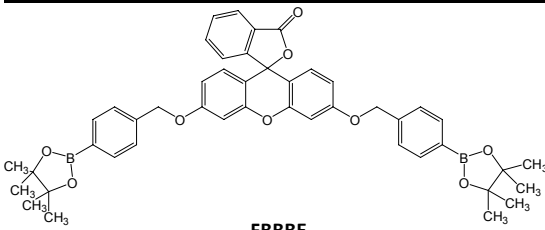
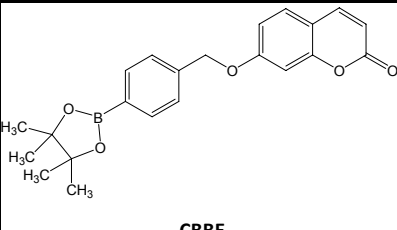
- Zirconium 1,4-dicarboxybenzene (UiO-66) is a versatile MOF that exhibits a number of favorable properties such as high surface area (ref. 1), high porosity and shear stability (ref. 2) and thermal stability (ref. 3).

References:

- J. Am. Chem. Soc.*, **2008**, 130, 13850.
- J. Phys. Chem. Lett.*, **2013**, 4, 925.
- Chem. Asian J.*, **2011**, 6, 3270.

BIOLOGICAL HYDROGEN PEROXIDE IMAGING KIT (FBBBE, CBBE)**96-0350 Biological Hydrogen Peroxide Imaging Kit (FBBBE, CBBE)****NEW→**

Contains the following:

Active Ingredients:	Catalog number 05-0058 Catalog number 05-0054	Fluorescein bis(benzyl boronic ester) FBBBE Coumarin benzyl boronic ester CBBE
 FBBBE  CBBE		
Introduction:	FBBBE and CBBE are robust fluorescent probes, effective for imaging hydrogen peroxide in biological settings. In the supplied form, the fluorescence signal is effectively quenched by the addition of the benzyl ether boronic ester protecting groups to the fluorophores. In the presence of biologically relevant levels of hydrogen peroxide (10-200 μM), the protecting groups cleave and a strong fluorescent signal is observed (FBBBE: λ_{exc} = 480 nm, λ_{em} = 512 nm; CBBE: λ_{exc} = 370 nm, λ_{em} = 450 nm) 1. <i>ChemBioChem</i>, 2013, 14, 593.	
Contents:	FBBBE: 3 x 5mg CBBE: 3 x 5mg Dimethylsulfoxide (ACS spectrophotometric grade): 6 x 1.0ml	
MSDS:	The Material Safety Data Sheets for the three products contained in this kit can be downloaded from the Strem Chemicals Web Site at www.strem.com. Locate the MSDS using the following catalog numbers: FBBBE: 05-0058 CBBE: 05-0054 Dimethylsulfoxide (ACS spectrophotometric grade): 97-4940	
Storage conditions:	Both compounds are stable at ambient conditions for several days. For long term storage, the kit should be stored at -20°C and protected from light.	
Preparation of FBBBE:	Step 1: Add 654 μL of DMSO to 5.0 mg FBBBE (MW: 764.3 g/mol) (resulting concentration = 10 mM). FBBBE is readily soluble in DMSO. The solution can be portioned into 50 mL aliquots as needed. These solutions must be stored in the freezer at < -20°C. Step 2: Add 50 mL of 10 mM stock to 50 mL DMSO (resulting concentration = 5 mM). This stock solution can be stored in the freezer at < -20°C. Step 3: This solution can be further diluted to the desired concentration in buffer. For example add 10 mL of the 5 mM stock solution to 990 mL 1X PBS, resulting in a 50 μM solution (this solution should be used the same day in which it was prepared). This will result in a solution containing only 1% DMSO (v/v). This solution can then be used in the biological setting to image H_2O_2	
Preparation of CBBE:	Step 1: Add 661 μL of DMSO to 5.0 mg CBBE (MW: 378.2 g/mol) (resulting concentration = 20 mM). Vortex until all solid has been thoroughly dissolved. The solution can be portioned into 50 mL aliquots as needed. These solutions must be stored in the freezer at < -20°C. Step 2: Add 50 mL of 20 mM stock to 150 mL DMSO (resulting concentration = 5 mM). This stock solution can be stored in the freezer at < -20°C. Step 3: This solution can be further diluted to the desired concentration in buffer. For example, add 10 mL of the 5 mM stock solution to 990 mL 1X PBS, resulting in a 50 μM solution (this solution should be used the same day in which it was prepared). This will result in a solution containing only 1% DMSO (v/v). This solution can then be used to image H_2O_2 in the biological setting.	

**CADMIUM SELENIDE/CADMIUM SULFIDE CANDOTS[®] QUANTUM ROD KIT,
5 mg/ml in hexane, 560nm, 590nm, 620nm PEAK EMISSIONS**

96-0813

**Cadmium selenide/cadmium sulfide CANDots[®] quantum rod kit, 5 mg/ml
in hexane, 560nm, 590nm, 620nm peak emissions**

NEW→

Components available for individual sale. Contains 0.5ml of the following:

48-1053	Cadmium selenide/cadmium sulfide CANDots [®] quantum rod (CdSe/CdS elongated core/shell), 5 mg/ml in hexane, 560nm peak emission [1306-24-7]	See page 54
48-1056	Cadmium selenide/cadmium sulfide CANDots [®] quantum rod (CdSe/CdS elongated core/shell), 5 mg/ml in hexane, 590nm peak emission [1306-24-7]	See page 54
48-1059	Cadmium selenide/cadmium sulfide CANDots [®] quantum rod (CdSe/CdS elongated core/shell), 5 mg/ml in hexane, 620nm peak emission [1306-24-7]	See page 55

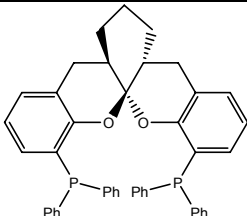
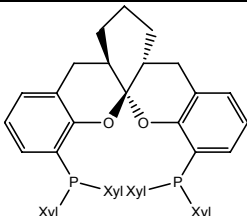
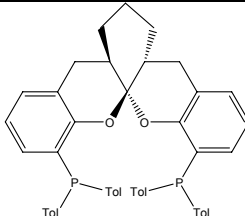
SKP LIGAND KIT for ASYMMETRIC-ALLYLIC AMINATION and CYCLOPROPANATION

96-2310

SKP Ligand Kit for asymmetric-allylic amination and cyclopropanation

NEW→

Components available for individual sale. Contains 25mg of the following:

		
15-4310 (R,R,R)-(+)-Ph-SKP 15-4311 (S,S,S)-(-)-Ph-SKP	15-4320 (R,R,R)-(+)-Xyl-SKP 15-4321 (S,S,S)-(-)-Xyl-SKP	15-4330 (R,R,R)-(+)-Tol-SKP 15-4331 (S,S,S)-(-)-Tol-SKP
15-4310 (+)-1,13-Bis(diphenyl)phosphino-(5aR,8aR,14aR)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (R,R,R)-(+)-Ph-SKP [1360823-43-3]	15-4320 (+)-1,13-Bis[di(3,5-dimethylphenyl)phosphino]-(5aR,8aR,14aR)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (R,R,R)-(+)-Xyl-SKP [1429939-35-4]	15-4330 (+)-1,13-Bis[di(4-methylphenyl)phosphino]-(5aR,8aR,14aR)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (R,R,R)-(+)-Tol-SKP [1429939-32-1]
15-4311 (-)-1,13-Bis(diphenyl)phosphino-(5aS,8aS,14aS)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (S,S,S)-(-)-Ph-SKP [1439556-82-7]	15-4321 (-)-1,13-Bis[di(3,5-dimethylphenyl)phosphino]-(5aS,8aS,14aS)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (S,S,S)-(-)-Xyl-SKP [1429939-31-0]	15-4331 (-)-1,13-Bis[di(4-methylphenyl)phosphino]-(5aS,8aS,14aS)-5a,6,7,8,8a,9-hexahydro-5H-[1]benzopyrano[3,2-d]xanthene, 97% (S,S,S)-(-)-Tol-SKP
See page 66	See page 64	See page 65
See page 66		See page 65
		See page 65
		See page 65

SpinPHOX-Ir CATALYST KIT for ENANTIOSELECTIVE HYDROGENATION

96-7710 SpinPHOX-Ir Catalyst Kit for enantioselective hydrogenation

NEW→ Components available for individual sale.

Contains 25mg of the following:

77-5040 (S,S)-(COD)Ir[Bn-SpinPHOX] 77-5041 (R,S)-(COD)Ir[Bn-SpinPHOX]	77-5046 (S,S)-(COD)Ir[Ph-SpinPHOX] 77-5047 (R,S)-(COD)Ir[Ph-SpinPHOX]	77-5050 (S,S)-(COD)Ir[iPr-SpinPHOX] 77-5051 (R,S)-(COD)Ir[iPr-SpinPHOX]
77-5040 1,5-Cyclooctadiene{(4S)-(+)-2-[(5S)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-benzoxazole}iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl] borate, 97% (S,S)-(COD)Ir[Bn-SpinPHOX] [1194050-19-5]		See page 50
77-5041 1,5-Cyclooctadiene{(4S)-(-)-2-[(5R)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-benzoxazole}iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl] borate, 97% (R,S)-(COD)Ir[Bn-SpinPHOX] [1195511-56-8]		See page 51
77-5046 1,5-Cyclooctadiene{(4S)-(+)-2-[(5S)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-phenyloxazole}iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl] borate, 97% (S,S)-(COD)Ir[Ph-SpinPHOX] [1194050-21-9]		See page 51
77-5047 1,5-cyclooctadiene{(4S)-(-)-2-[(5R)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-phenyloxazole}iridium(I) tetrakis[3,5-bis(trifluoromethyl)phenyl]borate, 97% (R,S)-(COD)Ir[Ph-SpinPHOX] [1195511-59-1]		See page 51
77-5050 1,5-cyclooctadiene{(4S)-(+)-2-[(5S)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-(i-propyl)oxazole}iridium(I)tetrakis[3,5-bis(trifluoromethyl)phenyl]borate, 97% (S,S)-(COD)Ir[iPr-SpinPHOX] [1194050-23-1]		See page 52
77-5051 1,5-cyclooctadiene{(4S)-(-)-2-[(5R)-6-(diphenylphosphino)spiro[4.4]nona-1.6-dien-1-yl]-4,5-dihydro-4-(i-propyl)oxazole}iridium(I)tetrakis[3,5-bis(trifluoromethyl)phenyl]borate, 97% (R,S)-(COD)Ir[iPr-SpinPHOX] [1195511-66-0]		See page 51

Recently Introduced - Biocatalyst Kits

Biocatalyst Kits

- 96-4010 Alcohol Dehydrogenase Kit (contains 35 variants)
- 96-4014 Aldehyde Dehydrogenase Kit (contains 5 variants)
- 96-4016 Aldehyde Reductase Kit (contains 10 variants)
- 96-4012 Cofactor Recycling Enzymes Kit (contains 8 cofactors)
- 96-4024 Ene Reductase Kit (contains 8 variants)
- 96-4018 Esterase Kit – Large (contains 50 variants)
- 96-4020 Esterase Kit – Medium (contains 30 variants)
- 96-4022 Lipase Kit (contains 12 variants)

(store cold at 4°C)

Sold in collaboration with JM for research purposes only.

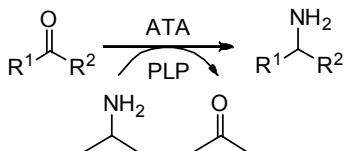
Visit www.strem.com for technical information including contents and reaction conditions of each kit.



Biocatalyst Kits – CODEX® ATA (AMINE TRANSAMINASE) SCREENING KITS

96-7125 Codex® ATA (Amine Transaminase) Screening Kit
NEW→ (100mg, ATASK-210100)

REACTION OF INTEREST



AMINE TRANSAMINASE CODEX® SCREENING KIT

The Codex® ATA Screening Kit contains 24 enzymes that have been selected to give the highest chance of identifying a hit for a broad range of substrates. The enzymes included in this kit were developed using Codexis' CodeEvolver™ directed evolution technology platform. This kit is a useful tool to quickly determine the feasibility of using an ATA for an asymmetric transamination.

Contains the following:

ATA enzymes - 100mg each
 PLP - 150mg

96-7130 Codex® ATA (Amine Transaminase) Screening Kit
NEW→ (250mg, ATASK-210250)

REACTION OF INTEREST

See 96-7125

Contains the following:

ATA enzymes - 250mg each
 PLP - 300mg

96-7135 Codex® ATA (Amine Transaminase) Screening Kit
NEW→ (1g, ATASK-211000)

REACTION OF INTEREST

See 96-7125

Contains the following:

ATA enzymes - 1g each
 PLP - 1.2g

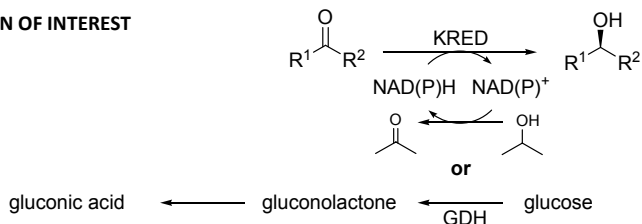
96-7140 Codex® ATA (Amine Transaminase) Screening Kit
NEW→ for Japan (100mg, ATASK-210100JAPAN)

96-7145 Codex® ATA (Amine Transaminase) Screening Kit
NEW→ for Japan (250mg, ATASK-210250JAPAN)

96-7150 Codex® ATA (Amine Transaminase) Screening Kit
NEW→ for Japan (1g, ATASK-211000JAPAN)

Store at -20°C. Sold under license from Codexis, Inc. for research purposes only.
 US Patent Nos. 8,293,507 and additional Codexis patents pending and granted worldwide.

Visit www.strem.com for detailed screening protocol.

Biocatalyst Kits – CODEX® KRED (KETOREDUCTASE) SCREENING KITS**96-7110 Codex® KRED (Ketoreductase) Screening Kit (100mg, KREDSK-010100)****NEW→****REACTION OF INTEREST****KETOREDUCTASE CODEX® SCREENING KIT**

The Codex® KRED Screening Kit contains 24 ketoreductases (KREDs) that have been selected for their high hit rate in ~70 screening projects. This kit is a useful tool to quickly determine the feasibility of using a KRED for an asymmetric ketone reduction.

Codex® KREDs have been engineered for enhanced selectivity, activity, substrate range, and solvent and temperature stability. These KREDs are tolerant to high concentrations of isopropanol (IPA) and can use IPA as a substrate. This is advantageous as high concentrations of IPA will assist in dissolving compounds with poor water solubility and the IPA can act as a substrate for the recycling of NADPH cofactor as shown in the scheme above. The reaction equilibrium is driven to product by using high concentrations of IPA and/or stripping off the acetone.

The 5 natural enzymes (1–5: KRED-101, KRED-119, KRED-130, KRED-NADH-101 and KRED-NADH-110, see table below) use Glucose/Glucose Dehydrogenase (GDH) instead of isopropanol for cofactor recycling.

KREDs 4 (KRED-NADH-101) and 5 (KRED-NADH-110) are NADH instead of NADPH dependent.

Contains the following:

24 ketoreductases (KREDs)	- 100mg each		
KRED Recycling mix N	- 32 g (0.56 L)	Cofactor Recycling System	- GDH/glucose
KRED Recycling mix P	- 49 g (1.6 L)	Cofactor Recycling System	- isopropanol

96-7115 Codex® KRED (Ketoreductase) Screening Kit (250mg, KREDSK-010250)**NEW→****REACTION OF INTEREST**

See 96-7110

Contains the following:

24 ketoreductases (KREDs)	- 250mg each		
KRED Recycling mix N	- 79.1 g (1.38 L)	Cofactor Recycling System	- GDH/glucose
KRED Recycling mix P	- 122 g (4.18 L)	Cofactor Recycling System	- isopropanol

96-7120 Codex® KRED (Ketoreductase) Screening Kit (1g, KREDSK-011000)**NEW→****REACTION OF INTEREST**

See 96-7110

Contains the following:

24 ketoreductases (KREDs)	- 1g each
NAD+	- 4.01 g
NADP+	- 4.63 g
GDH-105	- 1.10 g

Additional materials required for the 1 g kit:

Triethanolamine, triethanolamine-HCl **OR** K₂HPO₄ and KH₂PO₄
 9.15 g MgSO₄ (hexahydrate)
 79.3 g glucose

Note: Store at -20°C. Sold under license from Codexis, Inc. for research purposes only.

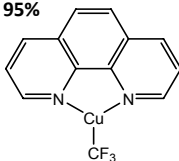
US Patent Nos. 7,820,421, 7,977,078, 8,288,131, and 8,288,141 and additional Codexis patents pending and granted worldwide.

Visit www.strem.com for detailed screening protocol.

COPPER Compounds

29-6720 Trifluoromethyl(1,10-phenanthroline)copper(I), 95%**NEW→ Trifluoromethylator®** [1300746-79-5](C₁₂H₈N₂)CuCF₃; FW: 312.76;orange solid *air sensitive*

Note: Sold under license from CATYLIX.



250mg

1g

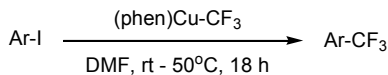
5g

25g

Larger Sizes +
Lower Prices

Technical Note:

1. Reagent used for the perfluoromethylation of arenes and aryl bromides and iodides.



Tech. Note (1)

Ref. (1,2)

References:

1. *Angew Chem. Int. Ed.*, **2011**, 50, 3793.
2. *Angew Chem. Int. Ed.*, **2012**, 51, 536.

What color is your catalyst?

Since Catalog No. 1, Strem has reported the color and form of every product. These are good indicators of quality, especially for metal catalysts.

Strem Catalog #46-2150 Tetrakis(triphenylphosphine)palladium(0), 99% (99.9+%-Pd)

Strem has manufactured the work-horse palladium catalyst “tetrakis” for many years. Various analytical techniques can be used to evaluate the quality of a catalyst and color can provide additional verification of quality. The tetrakis sample on the right demonstrates what can happen if it is not handled, packaged or stored under the right conditions. While the tan sample may pass several QC criteria, it would fail Strem’s color test. Color to the naked-eye can be good qualitative test of product quality!



Sample with the “right” color.



Sample with the “wrong” color.

Strem has many years of experience in the synthesis, isolation, handling, packaging and storage of this catalyst. If you need 25 grams or 25 kilograms, your tetrakis from Strem will be **bright yellow**.



From grams



To multi-kilograms

THE STREM CHEMIKER

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Metal Alkyls & Alkylamides

Metal Carbonyls & Derivatives

Metal Catalysts & Chiral Catalysts

Metal Foils, Wires, Powders & Elements

Metal Halides, Hydrides & Deuterides

Metal Oxides, Nitrates, Chalcogenides

Metal Scavengers

Metalloenes

Nanomaterials

Organofluorines

Organometallics

Organophosphines & Arsines

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Precious Metal & Rare Earth Chemicals

Volatile Precursors for MOCVD, CVD & ALD

Bulk Manufacturing, Custom Synthesis

cGMP facilities

Stock status on-line.

www.strem.com

