Coupling Catalysis Application Table

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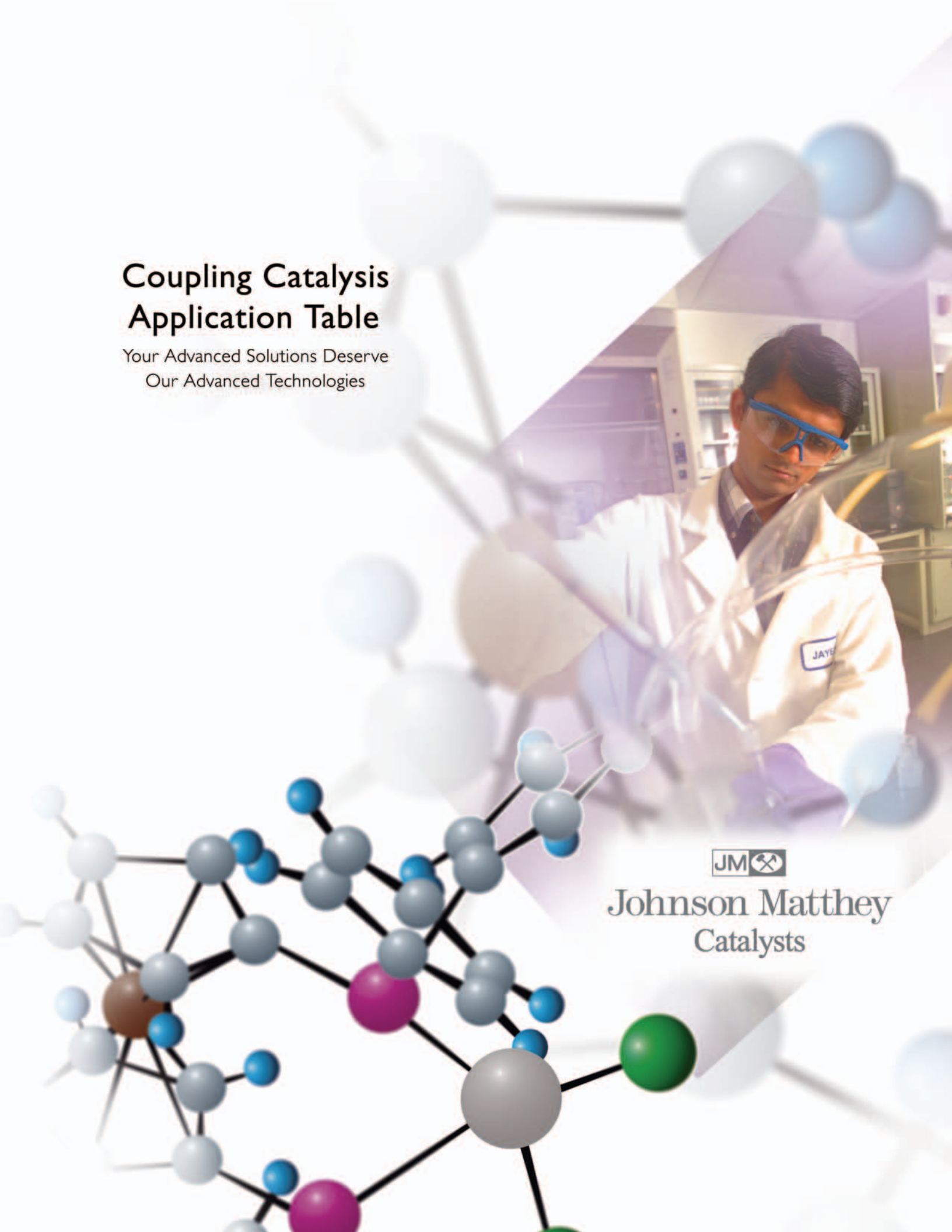

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Johnson Matthey
Catalysts

Carbon–Carbon

	Excellent	Good	Fair
Ar-OTf	Pd-113 Pd-118 Pd-121 FC1032 Pd-116 Pd-119 Pd-122	Pd-105 Pd-109 Pd-117 Pd-124 Q-Phos Pd-106 Pd-114 Pd-120 Pd-125 Pd-107 Pd-115 Pd-123 Pd-126	Pd-100 Pd-102 Pd-104 Pd-101 Pd-103
Ar-I	Pd-100 Pd-106 Pd-116 Pd-122 Q-Phos Pd-101 Pd-107 Pd-117 Pd-123 Pd-102 Pd-109 Pd-118 Pd-124 Pd-103 Pd-113 Pd-119 Pd-125 Pd-104 Pd-114 Pd-120 Pd-126 Pd-105 Pd-115 Pd-121 FC1032		
Neutral/Activated Ar-Br	Pd-106 Pd-114 Pd-118 Pd-122 Q-Phos Pd-107 Pd-115 Pd-119 Pd-123 Pd-109 Pd-116 Pd-120 Pd-124 Pd-113 Pd-117 Pd-121 Pd-125	Pd-100 Pd-102 Pd-104 Pd-126 Pd-101 Pd-103 Pd-105	
Unactivated Ar-Br	Pd-113 Pd-118 FC1032 Pd-116 Pd-122 Q-Phos	Pd-106 Pd-109 Pd-115 Pd-107 Pd-114 Pd-119	Pd-105 Pd-121 Pd-125 Pd-117 Pd-123 Pd-126 Pd-120 Pd-124
Activated Ar-Cl	Pd-113 Pd-116 Pd-118 FC1032 Pd-114 Pd-117 Pd-122 Q-Phos	Pd-105 Pd-107 Pd-116 Pd-120 Pd-126 Pd-106 Pd-109 Pd-119 Pd-121	Pd-102 Pd-123 Pd-103 Pd-124 Pd-104 Pd-125
Unactivated Ar-Cl	Pd-113 Pd-116 Pd-118 Pd-122 Q-Phos	FC1032	Pd-105 Pd-119 Pd-114 Pd-126
Heterocycles	Pd-113 Pd-118 FC1032 Pd-116 Pd-122 Q-Phos	Pd-119 Pd-122	Pd-114 Pd-117

Catalysts

Catalog No.	CAS No.	Catalyst	Stability	Mol. Wt.	Appearance
Pd-100	13965-03-2	dichlorobis(triphenylphosphine)palladium(II)	1	701	yellow solid
Pd-101	14221-01-3	tetrakis(triphenylphosphine)palladium(0)	6	1154	yellow solid
Pd-102	149796-59-8	diacetato[1,3-bis(diphenylphosphino)propane]palladium(II)	7	636	cream solid
Pd-103	19978-61-1	dichloro[1,2-bis(diphenylphosphino)ethane]palladium(II)	1	575	white solid
Pd-104	14588-08-0	diacetatobis(triphenylphosphine)palladium(II)	2	749	yellow solid
Pd-105	29964-62-3	dichloro[1,4-bis(diphenylphosphino)butane]palladium(II)	1	603	yellow solid
Pd-106	95464-05-4	dichloro[1,1'-bis(diphenylphosphino)ferrocene]palladium(II)-dichloromethane adduct	1	816	orange/red crystals
Pd-107	851232-71-8	dichloro[1,1'-bis(diphenylphosphino)ferrocene]palladium(II)-acetone adduct	1	789	brick red crystals
Pd-109	217189-40-7	di-μ-chlorobis(tris(2,4-di-*tert*-butylphenyl)phosphite-2-C,P)dipalladium(II)	1	1576	white/off white solid
Pd-113	185812-86-6	di-μ-bromobis(tri-*tert*-butylphosphine)dipalladium(I)	4	777	dark green crystals
Pd-114	29934-17-6	dichlorobis(tricyclohexylphosphine)palladium(II)	1	738	yellow solid
Pd-115	40691-33-6	dichlorobis(tri-*ortho*-tolylphosphine)palladium(II)	1	786	yellow/orange solid
Pd-116	53199-31-8	bis(tri-*tert*-butylphosphine)palladium(0)	5	510	white crystals
Pd-117	205319-06-8	dichloro[bis(diphenylphosphinophenyl)ether]palladium(II)	1	719	light yellow solid
Pd-118	95408-45-0	dichloro[1,1'-bis(di-*tert*-butylphosphino)ferrocene]palladium(II)	1	651	dark red/brown solid
Pd-119	215788-65-1	dichloro[1,1'-bis(di-isopropylphosphino)ferrocene]palladium(II)	1	637	orange solid
Pd-120	24554-43-6	dibromobis(tri-*ortho*-tolylphosphine)palladium(II)	3	875	orange/yellow solid
Pd-121	124268-93-5	dibromo[1,1'-bis(diphenylphosphino)ferrocene]palladium(II)	1	820	purple/red solid
Pd-122	34409-44-4	dichlorobis(di-*tert*-butylphenylphosphine)palladium(II)	3	622	pale yellow-white solid
Pd-123	253157-79-8	dichloro(2,2'-bis(diphenylphosphino)-1,1'-binaphthyl)palladium(II)	1	800	yellow crystals
Pd-124	366488-99-5	dibromo(2,2'-bis(diphenylphosphino)-1,1'-binaphthyl)palladium(II)	1	866	yellow crystals
Pd-125	unassigned	diiodo(2,2'-bis(diphenylphosphino)-1,1'-binaphthyl)palladium(II)	1	982	yellow crystals
Pd-126	59831-02-6	dichloro[1,3-bis(diphenylphosphino)propane]palladium(II)	1	590	pale yellow-white
FibreCat 1032	unassigned	Fiber supported Pd /P^tBu_3 catalyst	1	n/a	yellow fiber
Q-Phos*	312959-24-3	1,2,3,4,5-pentaphenyl-1'-(di-*tert*-butylphosphino)ferrocene	1	711	pink powder

* Q-Phos to be used in conjunction with palladium precursors such as Pd-93, 94, 95, 111

Carbon-Nitrogen

	Excellent	Good	Fair
Ar-OTf	Pd-106 Pd-113 Pd-118 Pd-122 Q-Phos Pd-107 Pd-116 Pd-121 FC1032	Pd-102 Pd-104 Pd-114 Pd-117 Pd-120 Pd-103 Pd-105 Pd-115 Pd-119 Pd-126	Pd-100 Pd-124 Pd-101 Pd-125 Pd-123
Ar-I	Pd-100 Pd-106 Pd-116 Pd-122 Q-Phos Pd-101 Pd-107 Pd-117 Pd-123 Pd-102 Pd-109 Pd-118 Pd-124 Pd-103 Pd-113 Pd-119 Pd-125 Pd-104 Pd-114 Pd-120 Pd-126 Pd-105 Pd-115 Pd-121 FC1032		
Neutral/Activated Ar-Br	Pd-106 Pd-113 Pd-116 Pd-119 FC1032 Pd-107 Pd-114 Pd-117 Pd-121 Q-Phos Pd-109 Pd-115 Pd-118 Pd-122	Pd-100 Pd-102 Pd-104 Pd-120 Pd-101 Pd-103 Pd-105 Pd-126	Pd-123 Pd-125 Pd-124
Unactivated Ar-Br	Pd-113 Pd-116 Pd-118 Pd-122 Q-Phos	Pd-114 Pd-115 Pd-117 Pd-119 FC1032	Pd-106 Pd-123 Pd-125 Pd-107 Pd-124
Activated Ar-Cl	Pd-113 Pd-118 FC1032 Pd-116 Pd-122 Q-Phos	Pd-106 Pd-107 Pd-114 Pd-117 Pd-119	Pd-105 Pd-121 Pd-125 Pd-115 Pd-123 Pd-126 Pd-120 Pd-124
Unactivated Ar-Cl	Pd-113 Pd-116 Pd-118 Pd-122 Q-Phos	Pd-119	Pd-114 Pd-115 FC1032

Alpha-Ketone Arylation

	Excellent	Good	Fair
Ar-I	Pd-113 Pd-119 Pd-122 Pd-116 Pd-120 FC1032 Pd-118 Pd-121 Q-Phos	Pd-100 Pd-104 Pd-109 Pd-123 Pd-101 Pd-105 Pd-114 Pd-124 Pd-102 Pd-106 Pd-115 Pd-125 Pd-103 Pd-107 Pd-117 Pd-126	
Ar-Br	Pd-113 Pd-119 Q-Phos Pd-116 Pd-122 Pd-118 FC1032	Pd-106 Pd-114 Pd-120 Pd-124 Pd-107 Pd-115 Pd-121 Pd-125 Pd-109 Pd-117 Pd-123	Pd-100 Pd-103 Pd-126 Pd-101 Pd-104 Pd-102 Pd-105
Ar-Cl	Pd-113 Pd-116 Pd-118	Pd-114 Pd-115 Pd-119 Q-Phos	

C-O & C-S

	Excellent	Good	Fair
Ar-OTf	Pd-113 Pd-116 Pd-118 Pd-122 Q-Phos	Pd-106 Pd-114 Pd-119 Pd-125 Pd-107 Pd-115 Pd-123 FC1032 Pd-109 Pd-117 Pd-124	Pd-100 Pd-104 Pd-126 Pd-101 Pd-105 Pd-102 Pd-120 Pd-103 Pd-121
Ar-I	Pd-113 Pd-116 Pd-118 Pd-122 Q-Phos	Pd-100 Pd-104 Pd-109 Pd-119 Pd-124 Pd-101 Pd-105 Pd-114 Pd-120 Pd-125 Pd-102 Pd-106 Pd-115 Pd-121 Pd-126 Pd-103 Pd-107 Pd-117 Pd-123 FC1032	
Ar-Br	Pd-113 Pd-116 Pd-118 Pd-122 Q-Phos	Pd-106 Pd-114 Pd-119 Pd-125 Pd-107 Pd-115 Pd-123 FC1032 Pd-109 Pd-117 Pd-124	Pd-100 Pd-104 Pd-126 Pd-101 Pd-105 Pd-102 Pd-120 Pd-103 Pd-121
Ar-Cl	Pd-113 Pd-116 Pd-118 Q-Phos	Pd-122 FC1032	

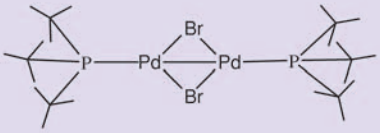
Precursors

The following precursors are available in research to commercial quantities. The activity and reactivity varies greatly depending on the choice of ligand. For technical recommendations, please contact the Johnson Matthey Technical Services Team at US: +1 856 384 7185 EU: +44 1763 256 261.

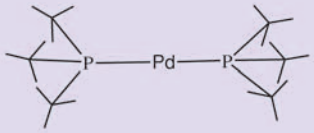
Catalog No.	CAS No.	Catalyst	Stability	Mol. Wt.	Appearance
Pd-61	14220-64-5	dichlorobis(benzonitrile)palladium(II)	1	384	yellow solid
Pd-62	14592-56-4	dichlorobis(acetonitrile)palladium(II)	1	259	dark yellow solid
Pd-70	14024-61-4	bis(acetylacetonato)palladium(II)	1	304	yellow/orange solid
Pd-90	12107-56-1	dichloro(1,5-cyclooctadiene)palladium(II)	1	286	yellow solid
Pd-91	12317-46-3	dichloro(norbornadiene)palladium(II)	1	269	yellow solid
Pd-93	32005-36-0	bis(dibenzylideneacetone)palladium(0)	3	575	dark purple solid
Pd-94	52409-22-0	tris(dibenzylideneacetone)dipalladium(0)	3	916	dark purple solid
Pd-95	52522-40-4	tris(dibenzylideneacetone)dipalladium(0) chloroform adduct	3	1035	dark purple solid
Pd-110	12012-95-2	allylpalladium chloride dimer	6	366	yellow solid
Pd-111	3375-31-3	palladium(II)acetate trimer	1	673	orange/brown needles

Stability Codes 1 - air stable 2 - very slightly air & moisture sensitive 3 - slightly air & moisture sensitive 4 - air & moisture sensitive 5 - air, moisture & light sensitive 6 - air, heat, light & moisture sensitive 7 - air stable & moisture sensitive

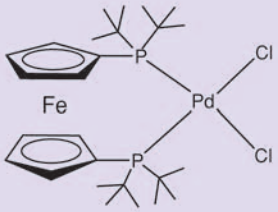
Highly Active Catalysts for Challenging Reactions



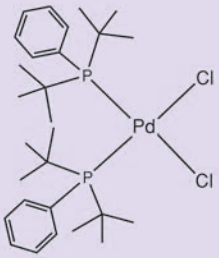
[Pd(*t*-Bu_3P)Br]$_2$ Pd-113



Pd(*t*-Bu_3P)$_2$ Pd-116



(d^{t}bpf)$PdCl_2$ Pd-118



(*t*-$Bu_2PhP)_2PdCl_2$ Pd-122

Handling and Storage of Air Sensitive Catalysts

To maintain optimal catalyst activity, we recommend the storage of air sensitive catalysts in a glove box maintained at approximately 3-5 PPM levels of oxygen and moisture. Any dispensing or repackaging of the material should be conducted under strict inert conditions, although catalysts in solid phases are stable in air for approximately one hour. Their rate of decomposition is significantly faster in solution phase even at room temperature. After packaging in a glove box, the catalyst may be stored in amber colored, air-less bottles in nitrogen filled Mylar bags, at temperatures of 0 - 20°C.

The illustrations below provide typical variations in color resulting from extended exposure to air and moisture. The changes in color indicate that the activity of the catalyst may be compromised. Our Technical Services Team is available to provide supplemental advice on catalyst storage and decomposition.

Pd 113

0 hrs. 48 hrs. 112 hrs.

Pd 116

0 hrs. 24 hrs. 96 hrs.

Pd 101

0 hrs. 24 hrs. 96 hrs.

Technical Support

For additional information on optimizing your coupling reactions with cutting edge technology, contact our Technical Services Team at:

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EU: +44 1763 256 261
Email: jmcouplingcatalysts@matthey.com
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Johnson Matthey Catalysts

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Articles for Coupling Applications Table

An Efficient Palladium-Catalyzed Heck Coupling of Aryl Chlorides with Alkenes
Chenyi Yi and Ruimao Hua
Tet. Lett., **2006**, *47*, 2573–2576

A Versatile Method for Suzuki Cross-Coupling Reactions of Nitrogen Heterocycles
Noriaki Kudo, Mauro Perseghini and Gregory C. Fu
Angew. Chem. Int. Ed., **2006**, *45*, 1282-1284

Efficient Copper-Free $PdCl_2(PCy_3)_2$-Catalyzed Sonogashira Coupling of Aryl Chlorides with Terminal Alkynes
Chenyi Yi and Ruimao Hua
J. Org. Chem., **2006**, *71*, 2535-2537

New Air-Stable Catalysts for General and Efficient Suzuki-Miyaura Cross-Coupling Reactions of Heteroaryl Chlorides
Anil S. Guram et al.
Org. Lett., **2006**, *8*, 9, 1787-1789

Organometallic Sandwich Compounds in Homogeneous Catalysis: An Overview
Thomas J. Colacot and Narayan S. Hosmane
Z. Anorg. Allg. Chem., **2005**, *631*, 2659-2668

$Cp_2Fe(PR_2)_2PdCl_2$ (R = *i*-Pr, *t*-Bu) Complexes as Air-Stable Catalysts for Challenging Suzuki Coupling Reactions
Thomas J. Colacot, and Helene A. Shea
Org. Lett., **2004**, *6*, 21, 3731-3734

Use of Polymer-Supported Pd Reagents for Rapid and Efficient Suzuki Reactions Using Microwave Heating
Ying Wang and Daryl R. Sauer
Org. Lett., **2004**, *6*, 16, 2793-2796

Palladium-Catalyzed Amination of Aryl Bromides with Hindered N-Alkyl-Substituted Anilines Using a Palladium(I) Tri-tert-butylphosphine Bromide Dimer
Mahavir Prashad, Xiao Yin Mak, Yugang Liu and Oljan Repic
J. Org. Chem., **2003**, *68*, 1163-1164

High-Throughput Screening Studies of Fiber-Supported Catalysts Leading to Room-Temperature Suzuki Coupling
Thomas J. Colacot, Ernest S. Gore, and Amanda Kuber
Organometallics, **2002**, *21*, 16, 3303

Ferrocenyl Phosphine Complexes of the Platinum Metals in Non-Chiral Catalysis: Their Applications in Carbon-Carbon and Carbon-Heteroatom Coupling Reactions
Thomas J. Colacot
Platinum Metals Review, **2001**, *45*, 22-30

Synthesis, X-ray, Spectroscopic and a Preliminary Suzuki Coupling Screening Studies of a Complete Series of dppfMX_2 (M=Pt, Pd;X=Cl, Br, I)
Thomas J. Colacot, Hu Qian, Raymundo Cea-Olivares, Simon Hernandez-Ortega
J. Org. Chem., **2001**, *637–639*, 691–697