chemistry

MERCK

クロスカップリング反応のための
Pd 触媒・配位子
アプリケーションガイド

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クロスカップリング反応のための Pd 触媒・配位子アプリケーション

パラジウムを利用するクロスカップリング反応は、C-C、C-N、C-O 結合を形成するための効率的な手法であり、現代の有機合成化学において最も重要な反応のひとつです。多くの触媒・前駆体が開発されており、それぞれのクロスカップリング反応に適した触媒と配位子を利用することが重要です。

主なクロスカップリング反応

Negishi (C-C)

R^1 = alkenyl, (hetero)aryl, alkynyl, acyl
R^2 = alkenyl, (hetero)aryl, alkynyl, alkyl
X = Cl, Br, I, OTf, OAc

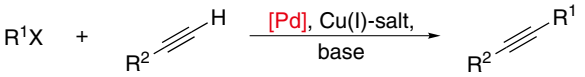
Heck (C-C)

R^1 = alkenyl, (hetero)aryl, alkyl (w/o β-hydrogens)
R^2 = alkenyl, (hetero)aryl, alkyl
X = Cl, Br, I, OTf, OTs, N_2^+

Suzuki (C-C)

R^1 = alkenyl, (hetero)aryl, alkyl
R^2 = alkenyl, (hetero)aryl, alkynyl, alkyl
Y = alkyl, OH, O-alkyl
X = Cl, Br, I, OTf

Sonogashira (C-C)

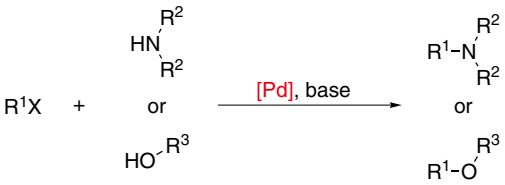


R^1 = alkenyl, (hetero)aryl
R^2 = H, alkenyl, (hetero)aryl, alkyl, SiR_3
X = Cl, Br, I, OTf

Stille (C-C)

R^1 = alkenyl, (hetero)aryl, acyl
R^2 = alkenyl, (hetero)aryl, alkyl
X = Cl, Br, I, OTf

Buchwald-Hartwig (C-N and/or C-O)



R^1 = (hetero)aryl
R^2 = 1°, 2° aryl or alkyl
R^3 = 1°, 2°, or 3° alkyl, aryl
X = Cl, Br, I, OTf

References:

– Negishi, E., Handbook of Organopalladium Chemistry for Organic Synthesis; John Wiley & Sons: New York, NY, 2002.
– Tsuji, J., Palladium Reagents and Catalysts: New Perspectives for the 21st Century; John Wiley & Sons: Chichester, West Sussex, England, 2004.
– Kürti, L. and Czakó, B. Strategic Applications of Named Reactions in Organic Synthesis; Elsevier Academic Press: Burlington, MA, 2005.
– Li, J. J. Named Reactions for Homologations; John Wiley & Sons: Hoboken, NJ, 2009.

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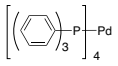
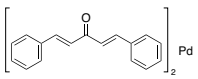
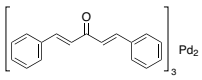
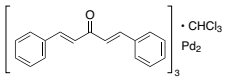
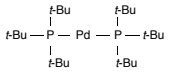
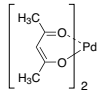
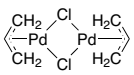
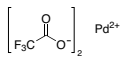
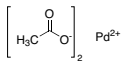
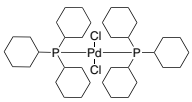
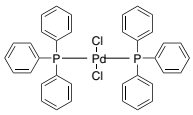
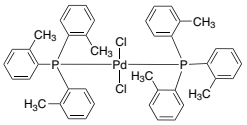
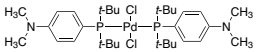
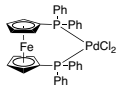
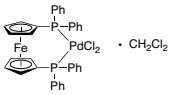
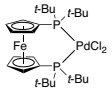
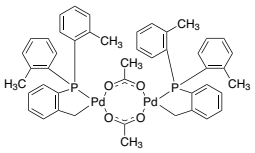
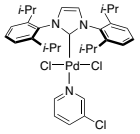
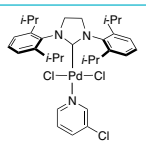
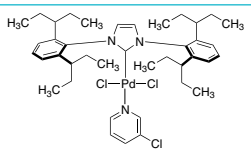
パラジウム触媒・前駆体

	カタログ番号	Common Name	CAS RN®	Mol. Wt.	Color	Stability	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig
	 **216666** (99%) **697265** (≧99.99%)	$Pd(PPh_3)_4$	14221-01-3	1155.56	Yellow	Air/Moisture Sensitive	✓	✓	✓		✓	✓
	 **227994**	$Pd(dba)_2$	32005-36-0	575.00	Black	Air/Moisture Sensitive	✓	✓	✓	✓		✓
	 **328774**	$Pd_2(dba)_3$	51364-51-3	915.72	Dark Purple to Black	Air Stable	✓	✓		✓		✓
	 **366315** (chloroform adduct of **328774**)	$Pd_2(dba)_3 \cdot CHCl_3$	52522-40-4	1035.10	Purple	Air Stable		✓		✓		✓
	 **676578**	$Pd(t\text{-}Bu_3P)_2$	53199-31-8	511.05	White to Off White	Air/Moisture Sensitive	✓	✓	✓	✓		✓
	 **209015** (99%) **683388** (99%)	$Pd(acac)_2$	14024-61-4	304.64	Yellow	Air Stable		✓		✓		✓
	 **222380**	$[Pd(allyl)Cl]_2$	12012-95-2	365.89	Yellow	Air/Moisture Sensitive		✓	✓	✓	✓	
	$(CH_3CN)_2PdCl_2$ **225657**	$Pd(MeCN)_2Cl_2$	14592-56-4	259.43	Dark Orange	Air Stable	✓	✓	✓		✓	
	 **299685**	$Pd(TFA)_2$	42196-31-6	332.45	Brown	Air Stable		✓		✓	✓	✓
	 **379875** (99.98%) **520764** (99.9%) **205869** (98%)	$Pd(OAc)_2$	3375-31-3	224.51	Orange-Brown	Air Stable	✓	✓	✓	✓		✓
	 **403237**	$Pd(PCy_3)_2Cl_2$	29934-17-6	738.18	Yellow	Air Stable		✓		✓	✓	✓
	 **412740**	$Pd(PPh_3)_2Cl_2$	13965-03-2	701.90	Yellow	Air/Moisture Sensitive	✓	✓	✓	✓	✓	

	カタログ番号	Common Name	CAS RN®	Mol. Wt.	Color	Stability	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig
	 **453048**	$Pd[P(o\text{-}tol)_3]_2Cl_2$	40691-33-6	786.06	Yellow	Air/Moisture Sensitive	✓	✓	✓	✓		✓
	 **678740**	$Pd(amphos)Cl_2$	887919-35-9	708.07	Yellow	Air Stable	✓	✓				
	 **697230**	$Pd(dppf)Cl_2$	72287-26-4	731.70	Red	Air Stable	✓	✓	✓			
	 **379670**	$Pd(dppf)Cl_2 \cdot CH_2Cl_2$	95464-05-4	816.64	Red	Air Stable	✓	✓	✓			
	 **701602**	$Pd(dtbpf)Cl_2$	95408-45-0	651.75	Brown	Air Stable		✓		✓		
	$Pd(CH_3CN)_4(BF_4)_2$ **339768**	$Pd(MeCN)_4(BF_4)_2$	21797-13-7	444.24	Dark Yellow	Air/Moisture Sensitive	✓	✓		✓		✓
	$PdBr_2$ **205877**	$PdBr_2$	13444-94-5	266.23	Dark Brown	Air Stable				✓	✓	✓
	$PdCl_2$ **520659**	$PdCl_2$	7647-10-1	177.33	Red-Brown	Air Stable		✓	✓	✓	✓	
	 **671916**	Herrmann' s Catalyst or cataCXium® C	172418-32-5	937.64	Light yellow	Air Stable				✓		
	 **669032**	Pd-PEPPSI ™ -IPr	905459-27-0	679.46	Yellow	Air Stable	✓	✓			✓	✓
	 **674702**	Pd-PEPPSI ™ -SIPr	927706-57-8	681.47	Yellow	Air Stable	✓	✓				✓
	 **732117**	Pd-PEPPSI ™ -IPent	1158652-41-5	791.67	Yellow	Air Stable	✓	✓	✓			

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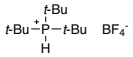
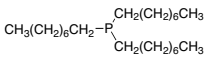
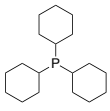
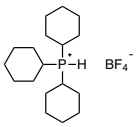
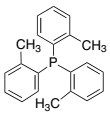
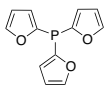
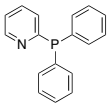
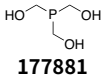
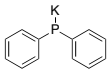
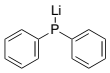
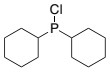
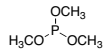
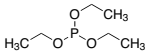
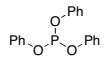
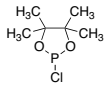
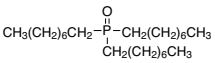
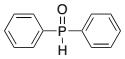
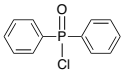
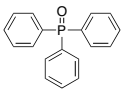
ホスフィン配位子

触媒反応における配位子は、中心金属原子を安定化・活性化し、反応の選択性をファインチューニングするために重要な役割を担います。触媒作用を高める高効率的な配位子が多数開発されていますが、クロスカップリング反応の配位子として、ホスフィン類が極めて有用であることは多くの知見からも明らかです。

Monodentate Phosphine Ligands and Precursors

カタログ番号	Common Name	CAS RN®	Mol. Wt.	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig (C–N or C–O)	Additional Applications
 **323322** **324108** (1.0 M in THF) **324116** (1.0 M in toluene)	PMe_3	594-09-2	76.08							• Mitsunobu reaction • Transformation of azides into carbamates • Aziridines from azidoalcohols • Reagent for iminophosphoranes • Aza-Wittig reaction
 **570958** **655325** (1.0 M in toluene)	$P(t\text{-Bu})_3$	13716-12-6	202.32	✓	✓	✓	✓	✓	✓	• Addition of organoboronic acids to aldehydes • Addition of alkynes to benzoylchlorides
 **578940**	$TTBP \cdot HBF_4$	131274-22-1	290.13	✓	✓	✓	✓	✓	✓	• Precusor for $P(t\text{-Bu})_3$ • Carbonylation • Addition of boronate esters to alkynes and alkenes
 **117854** (90%) **718165** (97%)	$P(n\text{-Oct})_3$	4731-53-7	370.64							• Surfactant for nanomaterial and nanocrystal synthesis • A general phosphorus source for the low-temperature conversion of metals into metal phosphides
 **261971**	$P(Cy)_3$	2622-14-2	280.43		✓		✓	✓		• Hiyama coupling
 **631493**	$P(Cy)_3 \cdot HBF_4$	58656-04-5	368.24		✓	✓		✓		• Control regiochemistry of hydrostannations of 1-alkynes • Intramolecular arylation • Synthesis of indolines from N-alkyl-2-bromoanilines
 **287822**	$P(o\text{-tol})_3$	6163-58-2	304.37	✓	✓	✓	✓		✓	• Silylation
 **265020**	Me_2PPh	672-66-2	138.15							• Ligand for transition metal complexes
 **383767**	TFP	5518-52-5	232.17	✓	✓	✓	✓	✓	✓	• Cycloisomerization/oxidation of alcohols
 **392960**	Diphenyl-2-pyridylphosphine	37943-90-1	263.27							• Carbonylations • Dehydrogenative coupling • Distannylation • Silylation • Carbostannylation • Hydration • Mitsunobu reaction
 **177881**	Tris(hydroxymethyl) phosphine	2767-80-8	124.08							• Precursor for metal complexes

Monodentate Phosphine Ligands and Precursors – 続き

カタログ番号	Common Name	CAS RN®	Mol. Wt.	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig (C–N or C–O)	Additional Applications
 **380768**	$KPPh_2$	15475-27-1	224.28							• Precusor for novel sulfur and phosphorus containing oxazolines used in asymmetric catalysis
 **464872**	Ph_2PLi	65567-06-8	192.12							• Dealkylation of alkyl aryl ethers • Dehydroxylation of α -hydroxy ketones
 **337773**	$P(i\text{-}Pr)_2Cl$	40244-90-4	152.60							• o-Arylation of phenols • Precusor for ligands and metal complexes
 **301558**	$P(t\text{-}Bu)_2Cl$	13716-10-4	180.66		✓					
 **481408**	Cy_2PCl	16523-54-9	232.73							• Precusor for phosphine ligands
 **92730** **240907**	$P(OMe)_3$	121-45-9	124.08		✓		✓			• Mild desulfurization reagent
 **T61204**	$P(OEt)_3$	122-52-1	166.16							• Reducing agent • Precusor for phosphonates or phosphates • Used with copper(I) iodide to form a stable metal complex
 **T84654**	$P(OPh)_3$	101-02-0	310.28			✓	✓			• Conversion of alcohols to halides • Wittig-type reaction • Deoxygenation • Cycloaddition reactions • Allylic alkylations • Cyclohydrocarbonylation/CO insertion • Wittig-type olefinations
 **447536**	2-Chloro-4,4,5,5-tetramethyl-1,3,2-dioxaphospholane	14812-59-0	182.59							• Reagent for the phosphitylation of alcohols and heteroatomic nucleophiles
 **223301** (99%) **346187** (90%)	TOPO®	78-50-2	386.63							• Agent for extraction of metals • Capping ligand for the production of quantum dots • Solvent for the synthesis and solubilizes the growing nanoparticles
 **287881**	$HPOPh_2$	4559-70-0	202.19		✓				✓	• Hydrophosphinylation of terminal alkynes • Selective hydrophosphinylation of olefins • Precursor for diphenylphosphino-containing chiral ligands
 **230235**	Ph_2POCl	1499-21-4	236.63							• Acid activation • Alkylphosphine oxide formation • Amine protection
 **T84603**	TPPO	791-28-6	278.28							• Catalyst for allylation of aldehydes or N-aryl hydrazones • Promoter for coupling reaction of 1-alkenyl with sulfonyl chlorides • Cocatalyst for enantioselective cyanosilylations • Tuning ligand for asymmetric epoxidation • Scavenger for enantioselective Michael reactions of enones

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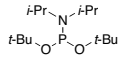
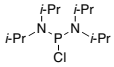
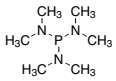
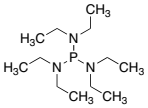
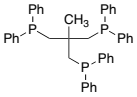
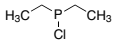
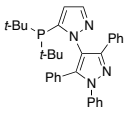
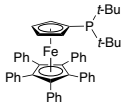
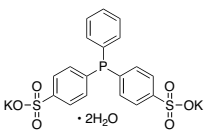
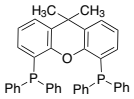
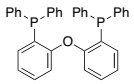
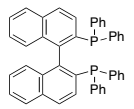
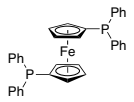
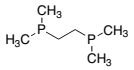
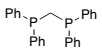
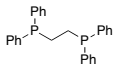
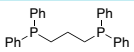
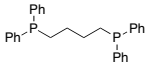
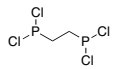
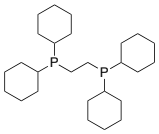
カタログ番号	Common Name	CAS RN®	Mol. Wt.	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig (C–N or C–O)	Additional Applications
 **389560**	$PhPOCl_2$	824-72-6	194.98							• Precursor for phosphonate ligands and metal complexes
 **419362**	Di-*tert*-butyl *N,N*-diisopropylphosphoramidite	137348-86-8	277.38							• Precursor for ligands • Reagent for the synthesis of nucleosides and nucleotides
 **341347**	Bis(diisopropylamino) chlorophosphine	56183-63-2	266.79							• Reagent for the synthesis of oligonucleotides
 **393290**	HMPT	1608-26-0	163.20		✓					• Synthesis of epoxides, arene oxides, and carbonates • Conversion of alcohols to alkyl chlorides • Conversion of disulfides to sulfides • Deoxygenation of sulfoxides and azoxyarenes • Reduction of ozonides • Replaces Ph_3P in the Wittig reaction
 **253189**	$P(NEt_2)_3$	2283-11-6	247.36							• Precursor for phosphine ligands and metal complexes
 **380741**	Triphos	22031-12-5	624.67							• Reagent for metal complexes
 **D71984**	$PhPCl_2$	644-97-3	178.98							• Precursor for phosphine ligands
 **573949**	Et_2PCl	686-69-1	124.55							• Precursor for phosphine ligands
 **676632**	BippyPhos	894086-00-1	506.62						✓	• Amidation • Coupling of hydroxylamines with aryl halides
 **675784**	QPhos	312959-24-3	710.71		✓			✓	✓	• α -Arylation of esters, amides and aldehydes
 **695467**	PTA	53597-69-6	157.15		✓			✓		• Morita–Baylis–Hillman reactions • Hydrogenations • Olefin hydroformylations • Cyclization
 **698539**	Bis(*p*-sulfonatophenyl) phenylphosphine dihydrate dipotassium salt	308103-66-4	534.62		✓					

Bidentate Phosphine Ligands and Precursors

カタログ番号	Common Name	CAS RN®	Mol. Wt.	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig (C–N or C–O)	Additional Applications
 **526460**	Xantphos	161265-03-8	578.62		✓	✓			✓	• C-P bond formation • Regioselective hydroformylation of allylamines • Borylation of nitriles
 **510017**	DPEPhos	166330-10-5	538.55	✓	✓		✓		✓	• Hydroamination
 **481084**	(±)-BINAP	98327-87-8	622.67			✓			✓	• Intramolecular acylation of aryl bromides • Minisci reaction with alcohols • Decarboxylative benzylation of diphenylglycinate Imines • Regioselective hydroarylation • Decarboxylative cycloaddition • S-arylation
 **460273**	dppbenz	13991-08-7	446.46							• Cycloadditions • Addition of arylboronic acids • Baeyer-Villiger oxidation • Reduction of propargyl oxiranes and hydroboration of styrene
 **177261**	dppf	12150-46-8	554.38	✓	✓	✓	✓	✓	✓	• Tsuji-Trost allylation • Carbonylation of vinyl triflates • Enantioselective ene reaction • Addition of organoboronic acids to aldehydes
 **261939**	dmpe	23936-60-9	150.14							• Ligand for metal complexes
 **127566**	dppm	2071-20-7	384.39		✓		✓			• Ligand for metal complexes
 **106496**	dppe	1663-45-2	398.42	✓	✓		✓			• Allylation of ketones • Decarboxylation of allyl esters • [3 + 2] cycloaddition • Carbonylation • Homo-Diels–Alder cycloaddition of norbornadiene with alkynes
 **262048**	dppp	6737-42-4	412.44	✓	✓			✓		• Deoxygenation of phenols via the corresponding triflate • Substitution of aryl bromides with vinyl ethers • Carbonylation of aryl triflates • Addition of β -dicarbonyl enolates to dienes • Coupling of aryl and alkyl halides with Grignard reagents
 **261947**	dppb	7688-25-7	426.47	✓	✓	✓	✓	✓		• Lactonization of unsaturated alcohol • Alkylation of allyl acetates • Hydroacylation • Alkyne Isomerizations • Intramolecular allylation of alkenes • Alkyne–CO_2 coupling
 **261920**	1,2-Bis(dichlorophosphino) ethane	28240-69-9	231.81							• Precusor for ligands and transition metal complexes
 **479500**	dcpe	23743-26-2	422.61	✓	✓					• Decarboxylative coupling • Ligand for metal complexes

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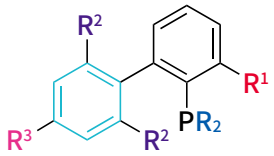
Buchwald 配位子

Buchwald 配位子は電子豊富でかさ高いジアルキルビアリールホスフィン骨格を有する配位子で、Pd 触媒の反応性を向上させることが知られています。極めて高活性なこの配位子は、創薬化学、天然物合成、高分子合成および新材料開発の分野で幅広く利用されています。ジアルキルビアリール骨格の構造により、触媒反応の効率が異なります。

ジアルキルビアリールホスフィン配位子の構造特性

R^2: シクロメタル化を防ぐことで触媒を安定化し、$L_1Pd(0)$の生成を促進する

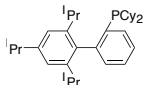
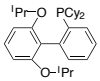
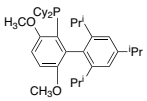
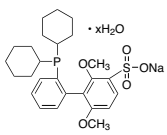
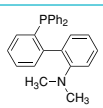
R^3: H原子以外の場合は、合成上の理由で導入されることが多い



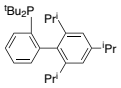
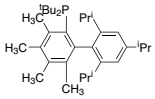
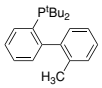
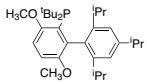
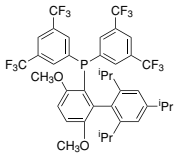
R^1: 置換基により還元的脱離を促進する

R: 電子豊富な置換基により酸化的付加を加速する

: P原子の酸素酸化を防ぎ、還元的脱離を加速する

カタログ番号	Common Name	CAS RN®	Mol. Wt.	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig (C–N or C–O)	Additional Applications
 638099	Cyclohexyl JohnPhos	247940-06-3	350.48	✓	✓				✓	• Hiyama coupling • Methylation of aryl halides • C-B bond formation • Oxidation of alcohols to ketones • α -Arylation of ketones
 638021	DavePhos	213697-53-1	393.54	✓	✓				✓	• Kumada-Corriu coupling and α -Arylation of ketones • Hydroamination
 638064	XPhos	564483-18-7	476.72	✓	✓	✓	✓	✓	✓	• Hiyama coupling • Carbonyl enolate coupling
 638072	SPhos	657408-07-6	410.53	✓	✓		✓		✓	• Kumada-Corriu coupling
 695262	MePhos	251320-86-2	364.5		✓				✓	• α -Arylation of ketones
 663131	RuPhos	787618-22-8	466.64	✓	✓			✓	✓	• α -Arylation of oxindoles
 718742	BrettPhos	1070663-78-3	536.77						✓	• Trifluoromethylation of aryl chlorides
 677280	sSPhos	1049726-96-6	512.57		✓					• 1, 2-addition of arylboronic acids to aldehydes and ketones
 695882	PhDavePhos	240417-00-9	381.45						✓	• Heteroarene benzylation

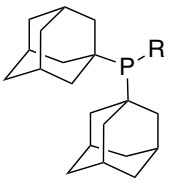
Buchwald 配位子 – 続き

カタログ番号	Common Name	CAS RN®	Mol. Wt.	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig (C–N or C–O)	Additional Applications
 638080	*t*BuXPhos	564483-19-8	424.64						✓	• α -Arylation of tetramic acids • Decarboxylative coupling of aromatic acids and aryl iodides • Carboxylation of aryl bromides with CO_2
 638439	JohnPhos	224311-51-7	298.40		✓		✓		✓	• C-Si bond formation
 675938	Tetramethyl di-*t*BuXPhos	857356-94-6	480.75						✓	• Conversion of aryl halides to phenols
 695211	*t*BuMePhos	255837-19-5	312.43				✓		✓	• α -Arylation of ketones • Formate reduction of *N*-heterocyclic allylic acetates
 730998	*t*BuBrettPhos	1160861-53-9	484.69						✓	• O-arylation of ethyl acetohydroximate • C-F bond formation • Conversion of aryl and vinyl triflates to bromides and chlorides • Conversion of aryl chlorides, triflates, and nonaflates to nitroaromatics
 695874	*t*BuDavePhos	224311-49-3	341.47						✓	• α -Arylation of esters • C-Si bond formation
 731013	JackiePhos	1160861-60-8	796.66						✓	• Coupling of aryl nonaflates and triflates with secondary amides, ureas, carbamates, and sulfonamides • Coupling of aryl chlorides with secondary amides, carbamates, and sulfonamides

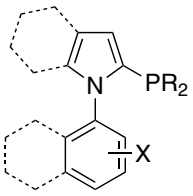
製品の技術的なお問い合わせはテクニカルサポートへ E-mail：jpts@merckgroup.com

cataCXium® 配位子

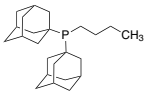
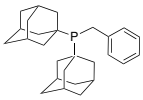
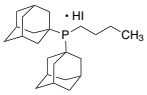
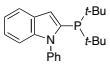
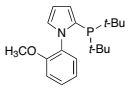
cataCXium® 配位子は、Pd 触媒クロスカップリング反応の高効率的な配位子です。電子豊富でかさ高いジアダマンチルアルキルホスフィン配位子である cataCXium A は、Heck 反応、鈴木 - 宮浦反応、塩化アリールの Buchwald-Hartwig アミノ化反応、ケトンのα - アリール化反応に利用されています。一般に、穏やかな反応条件下、少量の触媒で反応が進行します。最近、*N*- アリールピロールを有する塩基性のかさ高い配位子 cataCXium P が開発され、電子不足 / 電子豊富な塩化アリールのいずれに対しても鈴木 - 宮浦反応で高いターンオーバー数が得られることが見出されました。



cataCXium® A



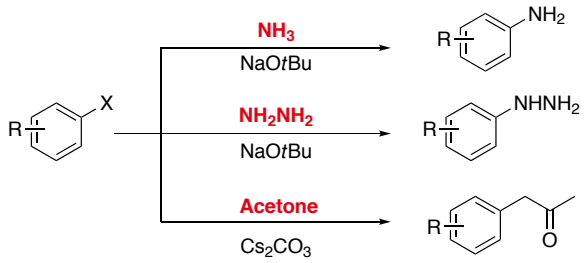
cataCXium® P

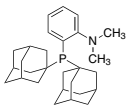
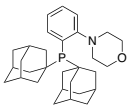
カタログ番号	Common Name	CAS RN®	Mol. Wt.	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig (C–N or C–O)	Additional Applications
 **671479**	cataCXium® A	321921-71-5	358.54		✓		✓	✓	✓	• Formylation of aryl bromides • Arylation
 **671800**	cataCXium® ABn	395116-70-8	392.56		✓			✓		
 **671584**	cataCXium® AHI	714951-87-8	486.45		✓				✓	• Arylation
 **672661**	cataCXium® PtB	672937-61-0	287.38		✓				✓	• Dehydrogenation of iso-propanol
 **672343**	cataCXium® PIntB	740815-37-6	337.44		✓			✓	✓	
 **672017**	cataCXium® PCy	672937-60-9	339.45		✓		✓		✓	• Amination of alcohols with ammonia
 **672564**	cataCXium® POMetB	1053658-91-5	317.41						✓	

DalPhos 配位子

DalPhos 配位子は、かさ高いジ (1- アダマンチル) ホスフィン骨格 [$P(1\text{-}Ad)_2$] を有する N,P キレート配位子で、C-N および C-C 結合形成反応に有用です。Mor-DalPhos は Me-DalPhos よりも反応性が高く、アンモニア、ヒドラジン、アセトンとのカップリング反応が室温で進行します。

[Pd]/Mor-DalPhos の利用例



カタログ番号	Common Name	CAS RN®	Mol. Wt.	Negishi	Suzuki	Stille	Heck	Sonogashira	Buchwald-Hartwig (C–N or C–O)	Additional Applications
 751413	Me-DalPhos	1219080-77-9	421.6			✓		✓	✓	
 751618	Mor-DalPhos	1237588-12-3	463.63			✓		✓	✓	• Monoarylation of hydrazine and acetone

シグマ アルドリッチ ジャパン リサーチ事業部

〒 153-8927 東京都目黒区下目黒 1-8-1 アルコタワー 5F

製品の最新情報はこちら www.sigma-aldrich.com/japan

製品に関するお問い合わせは、テクニカルサービスへ
E-mail: jpts@merckgroup.com Tel: 03-6756-8245 Fax: 03-6756-8302

在庫照会・ご注文に関するお問い合わせは、カスタマーサービスへ
E-mail: sialjpcs@merckgroup.com Tel: 03-6756-8275 Fax: 03-6756-8301

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