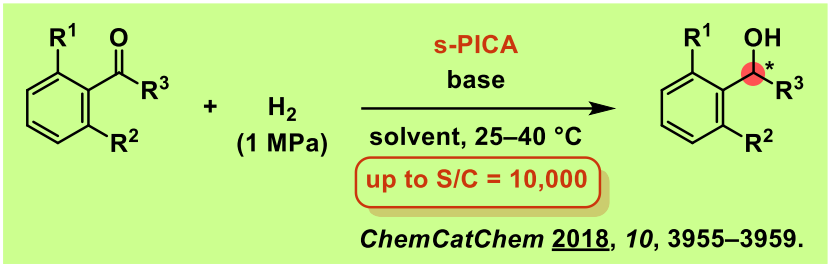
- Asymmetric Hydrogenation
- Asymmetric Transfer Hydrogenation

Asymmetric Hydrogenation Catalysts (s-PICA)



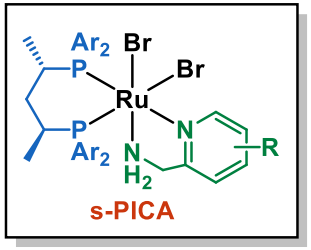
ChemCatChem 2018, *10*, 3955–3959.

- Preparation of chiral secondary alcohols
- Using hydrogen gas as a hydrogen source
- Excellent reactivity and enantioselectiviy
- Excellent for bulky acetophenones, ketoesters…
- Very unique substrate scope

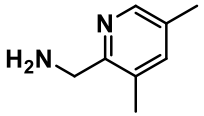
Ruthenium Complexes for Asymmetric Hydrogenation

Skewphos derivatives

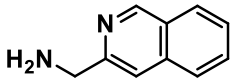
(*S*,*S*) or (*R*,*R*)
XylSkewphos (Ar = 3,5-$Me_2C_6H_3$)
DIPSkewphos (Ar = 3,5-*i*-$Pr_2C_6H_3$)



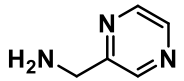
PICA derivatives



3,5-DMPICA



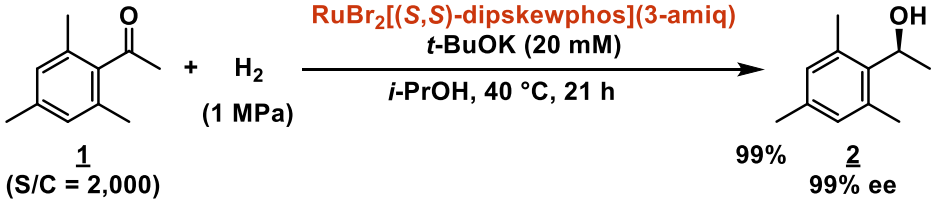
3-AMIQ



AMPZ

Please see the brochure for details https://www.kanto.co.jp/dcms_media/other/OEA-07_EN.pdf

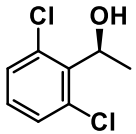
Typical Procedure & Substrate Scope



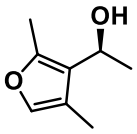
1 (S/C = 2,000)

99% **2** 99% ee

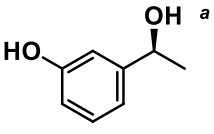
Substrate scope



99% yield
99% ee



93% yield
95% ee

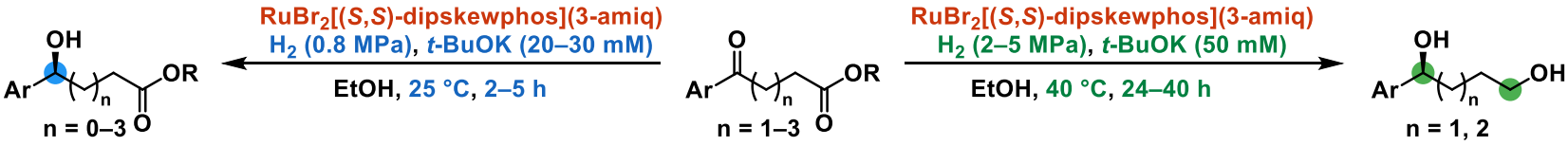


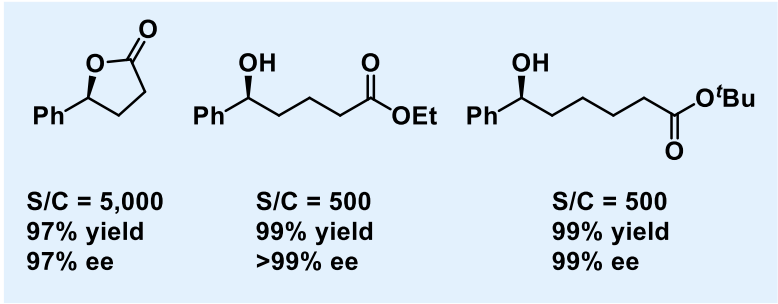
99% yield
97% ee

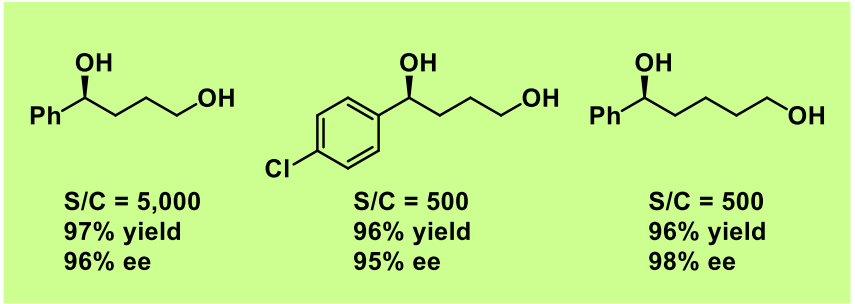
[a] *t*-BuOK/ketone = 1/1

$RuBr_2$[(*S*,*S*)-dipskewphos](3-amiq) (1.2 mg, 1.0 μmol), *t*-BuOK (3.4 mg, 31 μmol) and a Teflon coated stirring bar were placed in a 100 mL glass autoclave that had been filled with argon. *i*-PrOH (0.68 mL) and ketone **1** (0.33 g, 2.0 mmol) were transferred into the autoclave by a syringe. The solution was degassed by five cycles of vacuum/filling with argon. Hydrogen was initially introduced into the autoclave at a pressure of 1 MPa then reduced to 0.1 MPa. This procedure was repeated five times. The autoclave was then pressurized with H_2 gas (1.0 MPa), and the solution was stirred vigorously at 40° C for 21 h. After careful release of the hydrogen, the solution was concentrated to give a crude product. Purification by silica gel column chromatography gave optically active alcohol **2** (0.33 g, 99%, 98% ee).

Chemoselectivity Control of Ketoesters



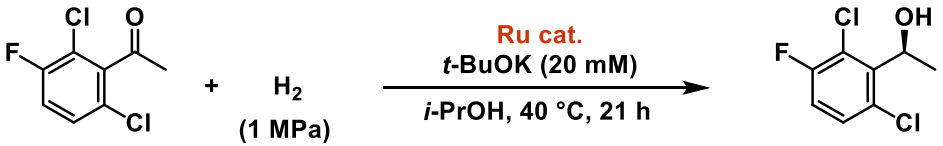




N. Arai, T. Namba, K. Kawaguchi, Y. Matsumoto, T. Ohkuma, *Angew.Chem.Int. Ed.* 2018, *57*, 1386–1389.

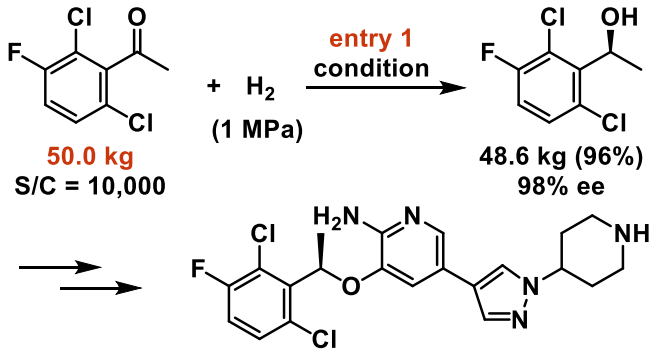
Performance of s-PICA

Comparison of catalytic reactivity

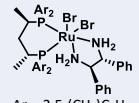
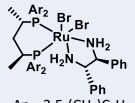
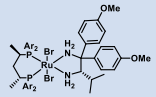
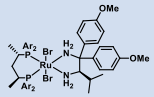
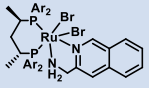
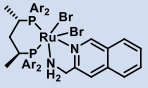
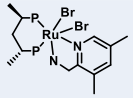
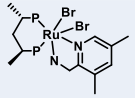
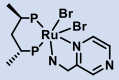
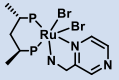
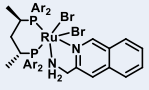
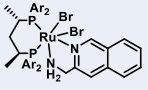
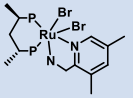
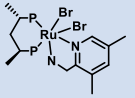
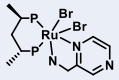
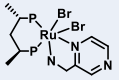


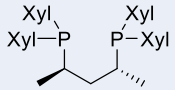
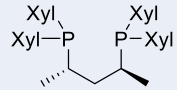
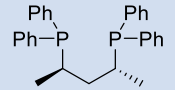
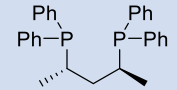
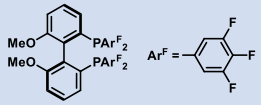
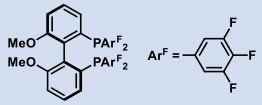
entry	Ru cat.	S/C	yield (%)	*ee* (%)
1	$RuBr_2$[(*S*,*S*)-xylskewphos](3,5-dmpica)	10,000	>99	98
2	$RuBr_2$[(*S*)-binap][(*S*,*S*)-dpen]	1,000	21	15
3	$RuBr_2$[(*S*,*S*)-xylskewphos][(*S*,*S*)-dpen]	1,000	28	27

Large scale synthesis of dichlorofluorophenylethanol

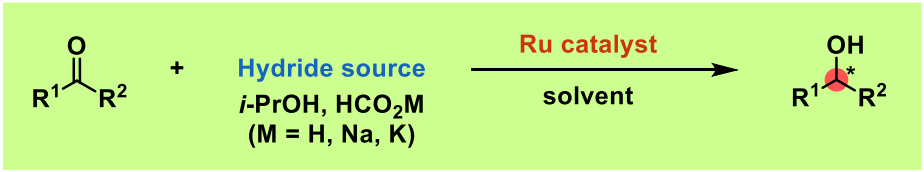


Crizotinib (anti-cancer drug)

Structure	Product No.	Package	Structure	Product No.	Package
Asymmetric Hydrogenation Catalysts					
 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*R*,*R*)-xylskewphos][(*R*,*R*)-dpen]	10535-68	100 mg	 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*S*,*S*)-xylskewphos][(*S*,*S*)-dpen]	10536-68	100 mg
 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*R*,*R*)-xylskewphos][(*S*)-daipen]	10537-68	100 mg	 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*S*,*S*)-xylskewphos][(*R*)-daipen]	10538-68	100 mg
s-PICA Catalysts					
 Ar = 3,5-$iPr_2C_6H_3$ $RuBr_2$[(*R*,*R*)-dipskewphos](3-amiq)	10164-68	100 mg	 Ar = 3,5-$iPr_2C_6H_3$ $RuBr_2$[(*S*,*S*)-dipskewphos](3-amiq)	10163-68	100 mg
 Ar = 3,5-$iPr_2C_6H_3$ $RuBr_2$[(*R*,*R*)-dipskewphos](3,5-dmpica)	10181-68	100 mg	 Ar = 3,5-$iPr_2C_6H_3$ $RuBr_2$[(*S*,*S*)-dipskewphos](3,5-dmpica)	10173-68	100 mg
 Ar = 3,5-$iPr_2C_6H_3$ $RuBr_2$[(*R*,*R*)-dipskewphos](ampz)	10166-68	100 mg	 Ar = 3,5-$iPr_2C_6H_3$ $RuBr_2$[(*S*,*S*)-dipskewphos](ampz)	10165-68	100 mg
 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*R*,*R*)-xylskewphos](3-amiq)	11215-68	100 mg	 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*S*,*S*)-xylskewphos](3-amiq)	11214-68	100 mg
 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*R*,*R*)-xylskewphos](3,5-dmpica)	11219-68	100 mg	 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*S*,*S*)-xylskewphos](3,5-dmpica)	11218-68	100 mg
 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*R*,*R*)-xylskewphos](ampz)	11217-68	100 mg	 Ar = 3,5-$(CH_3)C_6H_3$ $RuBr_2$[(*S*,*S*)-xylskewphos](ampz)	11216-68	100 mg

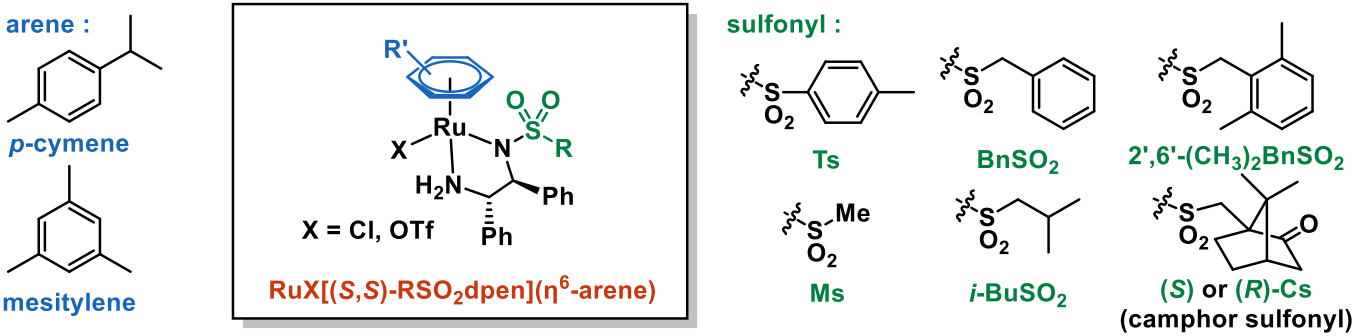
Structure	Product No.	Package	Structure	Product No.	Package
Chiral Diphosphine Ligands					
 (*R*,*R*)-XylSKEWPHOS	05842-68	200 mg	 (*S*,*S*)-XylSKEWPHOS	05843-68	200 mg
 (*R*,*R*)-SKEWPHOS	05840-65	200 mg	 (*S*,*S*)-SKEWPHOS	05841-65	200 mg
(*R*)-(+)-BINAP	04969-65	1 g	(*S*)-(−)-BINAP	04970-65	1 g
	04969-55	5 g		04970-55	5 g
	04969-35	25 g		04970-35	25 g
(*R*)-(+)-Tol-BINAP	41105-65	1 g	(*S*)-(−)-Tol-BINAP	41106-65	1 g
	41105-55	5 g		41106-55	5 g
(*R*)-(+)-Xyl-BINAP	46101-65	1 g	(*S*)-(−)-Xyl-BINAP	46102-65	1 g
	46101-55	5 g		46102-55	5 g
 (*R*)-MeO-F_{12}-BIPHEP	25970-95	200 mg	 (*S*)-MeO-F_{12}-BIPHEP	25971-95	200 mg

Asymmetric Transfer Hydrogenation Catalysts



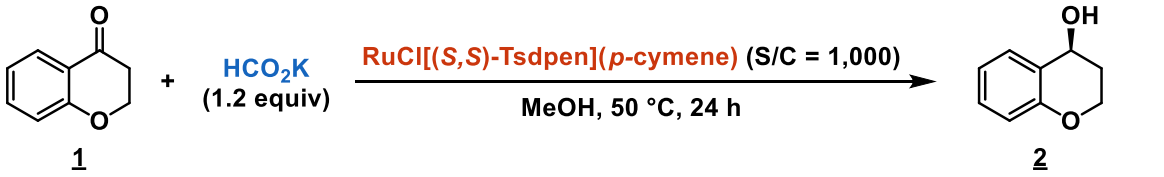
- Preparation of chiral secondary alcohols
- Using formate as a hydrogen source
- Suitable for base-sensitive ketones
- Excellent for cyclic ketones

Chiral Ruthenium Complexes for Asymmetric Transfer Hydrogenation



Please see the brochure for details
https://www.kanto.co.jp/dcms_media/other/Modified%20asymetric%20transfer%20hydrogenation%20catalysts%20%26%20Triflate%20catalysts_OEA-03E.pdf

Typical Procedure

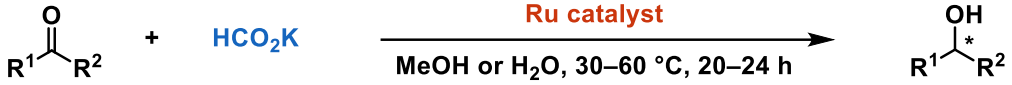


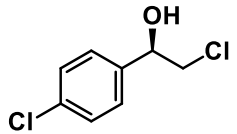
1

2
100% yield, 99% ee
JP 5680878

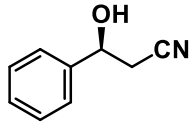
To a solution of ketone **1** (1.48 g, 10 mmol) in MeOH (6 mL) was added potassium formate (1.0 g, 12 mmol) and **Ru catalyst** (6.4 mg, 0.01 mmol) under argon atmosphere. After stirring for 24 h at 50 °C, the reaction was completed (100% conversion) and the solution was cooled down and diluted with H_2O. The solution was extracted with EtOAc, and the combined organic solvent was concentrated to afford alcohol **2** (99% ee).

Substrate Scope

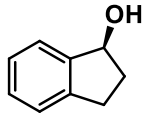




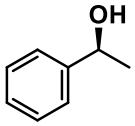
RuCl[(*S,S*)-2',6'-$(CH_3)_2$BnSO$_2$dpen](mesitylene)
S/C = 1,000, 98% yield, 98% ee



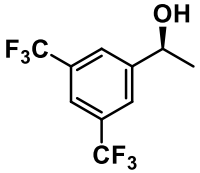
RuCl[(*S,S*)-Tsdpen](*p*-cymene)
S/C = 1,000, 90% yield, 95% ee



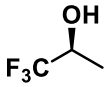
RuCl[(*S,S*)-BnSO$_2$dpen](mesitylene)
S/C = 18,000, 99% yield, 96% ee



RuCl[(*S,S*)-BnSO$_2$dpen](mesitylene)
S/C = 3000, 99% yield, 96% ee

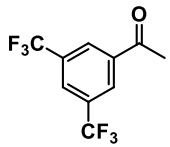


RuCl[(*S,S*)-2',6'-$(CH_3)_2$BnSO$_2$dpen](mesitylene)
S/C = 6,500, >99% yield, 97% ee



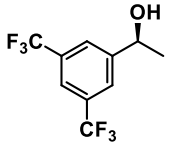
RuCl[(*S,S*)-Tsdpen](*p*-cymene)
S/C = 700, >99% yield, 97% ee

Large Scale Reaction



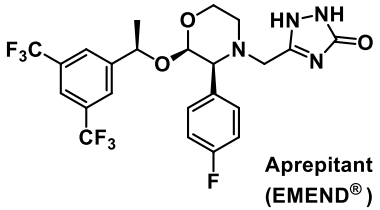
50 kg scale

RuCl[(*S,S*)-2',6'-$(CH_3)_2$BnSO$_2$dpen](mesitylene)
(S/C = 6,500)
HCO_2K
H_2O, 53 °C, 24 h; recrystallization



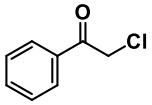
72% isolated yield
99% ee
Ru < 1 ppm

Relative API



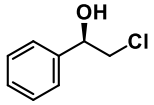
Aprepitant
(EMEND®)

Asymmetric Hydrogenation



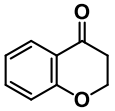
+ H_2
1 MPa

Ru(OTf)[(*S,S*)-Tsdpen](mesitylene)
(S/C = up to 4,000)
CH_3OH, 60 °C, 16 h



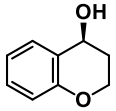
100% yield, 98% ee

Org. Lett. **2007**, *9*, 2565



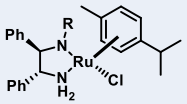
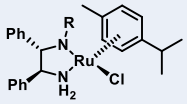
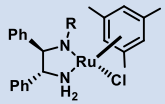
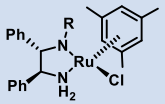
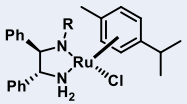
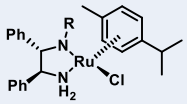
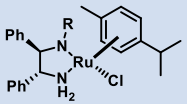
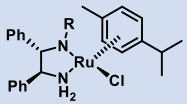
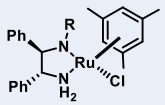
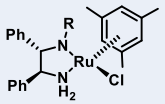
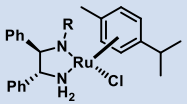
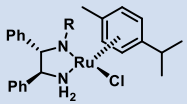
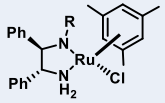
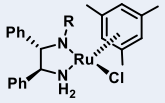
+ H_2
1 MPa

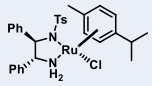
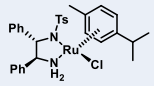
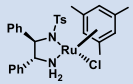
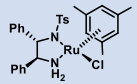
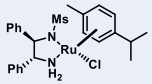
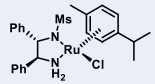
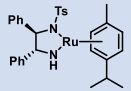
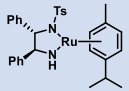
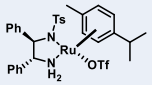
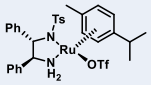
Ru(OTf)[(*S,S*)-Tsdpen](mesitylene)
(S/C = up to 7,000)
CH_3OH, 60 °C, 15 h



100% yield, 97% ee

J. Am. Chem. Soc. **2006**, *128*, 8724

Structure	Product No.	Package	Structure	Product No.	Package
Modified Asymmetric Transfer Hydrogenation Catalysts					
 R = SO_2*i*Bu RuCl[(*R*,*R*)-*i*BuSO_2dpen](*p*-cymene)	07710-95	200 mg	 R = SO_2*i*Bu RuCl[(*S*,*S*)-*i*BuSO_2dpen](*p*-cymene)	07711-95	200 mg
 R = SO_2*i*Bu RuCl[(*R*,*R*)-*i*BuSO_2dpen](mesitylene)	07721-95	200 mg	 R = SO_2*i*Bu RuCl[(*S*,*S*)-*i*BuSO_2dpen](mesitylene)	07722-95	200 mg
 R = (*R*)-camphorsulfonyl RuCl[(*R*)-Cs-(*R*,*R*)-dpen](*p*-cymene)	07715-95	200 mg	 R = (*S*)-camphorsulfonyl RuCl[(*S*)-Cs-(*S*,*S*)-dpen](*p*-cymene)	07716-95	200 mg
 R = SO_2Bn RuCl[(*R*,*R*)-BnSO_2dpen](*p*-cymene)	07717-95	200 mg	 R = SO_2Bn RuCl[(*S*,*S*)-BnSO_2dpen](*p*-cymene)	07718-95	200 mg
 R = SO_2Bn RuCl[(*R*,*R*)-BnSO_2dpen](mesitylene)	07719-95	200 mg	 R = SO_2Bn RuCl[(*S*,*S*)-BnSO_2dpen](mesitylene)	07720-95	200 mg
 R = 2′,6′-$(CH_3)_2$Bn RuCl[(*R*,*R*)-2′,6′-$(CH_3)_2$BnSO_2dpen](*p*-cymene)	07734-95	200 mg	 R = 2′,6′-$(CH_3)_2$Bn RuCl[(*S*,*S*)-2′,6′-$(CH_3)_2$BnSO_2dpen](*p*-cymene)	07735-95	200 mg
 R = 2′,6′-$(CH_3)_2$Bn RuCl[(*R*,*R*)-2′,6′-$(CH_3)_2$BnSO_2dpen](mesitylene)	07736-95	200 mg	 R = 2′,6′-$(CH_3)_2$Bn RuCl[(*S*,*S*)-2′,6′-$(CH_3)_2$BnSO_2dpen](mesitylene)	07737-95	200 mg

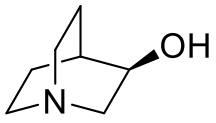
Structure	Product No.	Package	Structure	Product No.	Package
Asymmetric Transfer Hydrogenation Catalysts					
 RuCl[(*R*,*R*)-Tsdpen](*p*-cymene)	08154-95	200 mg	 RuCl[(*S*,*S*)-Tsdpen](*p*-cymene)	08153-95	200 mg
 RuCl[(*R*,*R*)-Tsdpen](mesitylene)	08173-95	200 mg	 RuCl[(*S*,*S*)-Tsdpen](mesitylene)	08174-95	200 mg
 RuCl[(*R*,*R*)-Msdpen](*p*-cymene)	08175-95	200 mg	 RuCl[(*S*,*S*)-Msdpen](*p*-cymene)	08176-95	200 mg
 Ru[(*R*,*R*)-Tsdpen](*p*-cymene)	41066-95	200 mg	 Ru[(*S*,*S*)-Tsdpen](*p*-cymene)	41067-95	200 mg
 Ru(OTf)[(*R*,*R*)-Tsdpen](p-cymene)	41068-95	200 mg	 Ru(OTf)[(*S*,*S*)-Tsdpen](p-cymene)	41069-95	200 mg

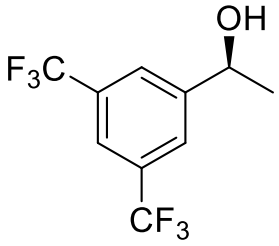
We provide not only reagents, but also bulk chemicals, contract synthesis, contract development and catalyst screening services. We are ready to help your research and industrial production.

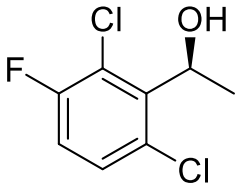
Our Products (Catalysts and Ligands)
https://www.kanto.co.jp/english/products/organics/organic03.html

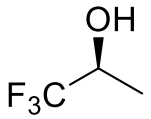
KANTO CHEMICAL CO.,INC.

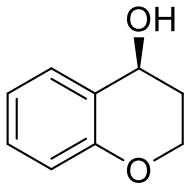
Product Examples We can Offer

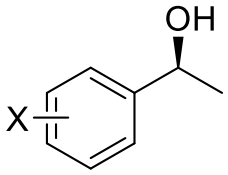


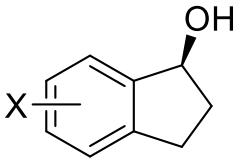


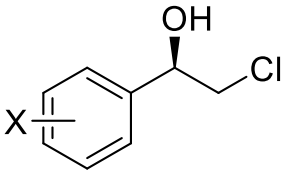


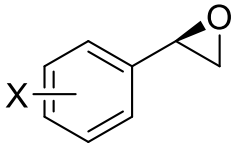


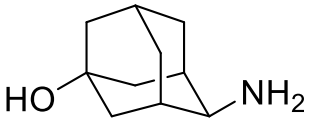


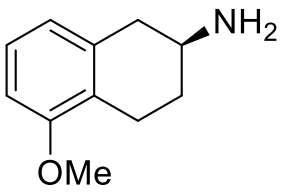


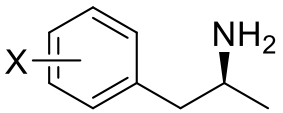


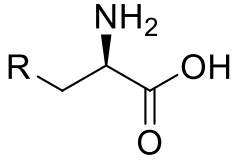


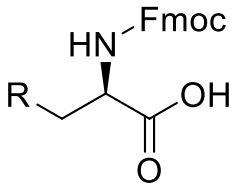


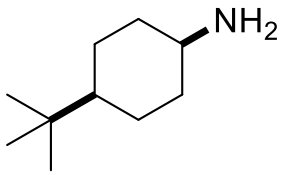






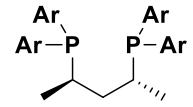




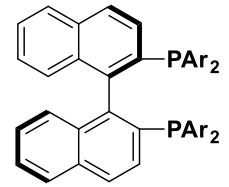


- We can also supply these compounds in bulk scale.
- Both enantiomers are available.
- Only a part of products is listed here.
- If you need other compounds, please feel free to contact us.

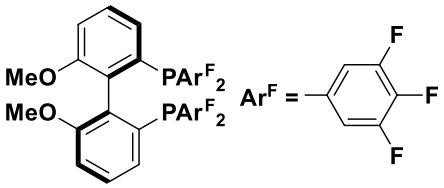
Ligand Examples We can Offer

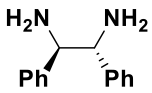


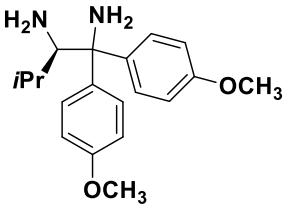
Ar = 3,5-*i*Pr$_2$C$_6$H$_3$
3,5-(CH$_3$)$_2$C$_6$H$_3$
Ph

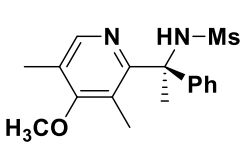


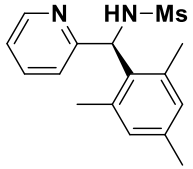
Ar = 3,5-(CH$_3$)$_2$C$_6$H$_3$
4-CH$_3$C$_6$H$_4$
Ph

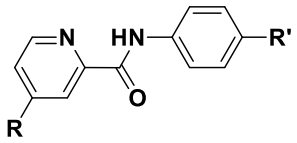


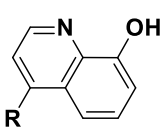


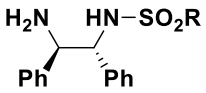




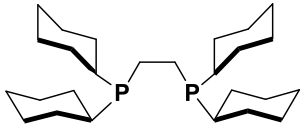


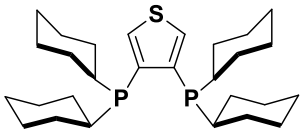


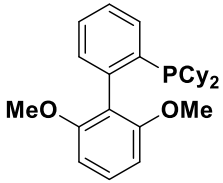


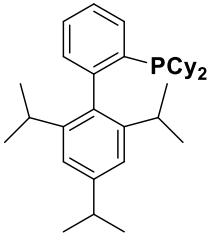


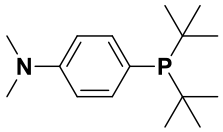
R = 4-(CH$_3$)C$_6$H$_4$
CH$_3$
Bn
2,6-(CH$_3$)$_2$Bn
*i*Bu
10-Camphor











- Both enantiomers are available.
- Only a part of ligands is listed here.
- If you need other ligands, please feel free to contact us.