Wako Product Update

GREEN CHEMISTRY

Please visit the Wako Online Catalog
http://search.wako-chem.com

Wako

No.4

Environmental Analysis

- Polymer-supported catalysts
- Catalysts for Organic Synthesis in water
- Solid Super-Acid Catalysts
- Chiral Phase-Transfer Catalysts
- Ionic Liquid
- Ligands
- Sulfur Compounds with Less Odor
- Polymer-supported Tosyloxylation Reaction
- Dehydrated Solvents

Analytical Chemistry

- Paper Fiber-made TLC Sheet

2003

GREEN CHEMISTRY

This century has been considered an age when people harmoniously coexist with nature: awareness for environmental protection has rapidly been raised on the global level and new relevant laws and regulations have been introduced every year.
In recent years, Green and Sustainable Chemistry (GSC), commonly known as Green Chemistry, has particularly drawn much attention, which has triggered many enterprises to start introducing the GSC concept in their business activities.
Recognizing the value of GSC in its early stage, Wako started developing reagents useful in promoting GSC ahead of other companies. In 1998 we launched the first GSC product, microencapsulated osmium (VIII) oxide (MC OsO_4) that had been developed by Professor Shu Kobayashi at the University of Tokyo. Wako has since continued to launch several products a year under the guidance of various professors and researchers of universities and research institutes.
This year marks the fifth anniversary of the development of the first GSC product. On this occasion, extending our gratitude toward professors who have cooperated in our GSC activities, we have posted on the Wako Product Update a feature article about our proprietary GSC-related reagents, mainly about commercialized products.

Index

A. Microencapsulated Catalysts

[Features]

1. **Readily recoerable and reusable by filtration**
2. **High catalytic activity**
3. **Utilizing patented technology that reduces release of catalyst from resin**
4. **Environmentally friendly**

Microencapsulated OsO_4, prepared from polystyrene based on the microencapsulated technique

Osmium (VIII) oxide, Microencapsulated is a useful, safe, non-volatile, recoverable and resuable catalyst for the asymmetric dihydroxylation of olefins on an industrial scale.

Low Toxicity due to Low Volatility

[Before] [After 3 days]

Osmium (VIII) oxide, Microencapsulated (MC OsO_4)

Cat. #153-02081 1 g

RT, Solid (black chipped mass)

MW : 254.23 (OsO_4)

CAS : 20816-12-0

OsO_4 content : approx. 10 %

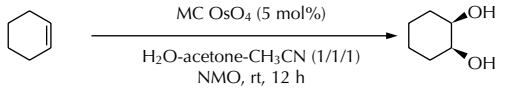
IATA : Not restricted

[Application]

Best applied when N-methylmorpholine-N-oxide (NMO) is used as a cooxidant.

[Reaction]

Recovery and reuse of MC OsO_4



Run	1	2	3	4	5
Yield of Product (%)	84	84	83	84	83
Recovery of Catalyst (%)	quant.	quant.	quant.	quant.	quant.

Osmium (VIII) oxide, PEM Microencapsulated (PEM-MC OsO_4)

Cat. #158-02411 1 g

RT, Solid (black chipped mass)

MW : 254.23 (OsO_4)

CAS : 20816-12-0

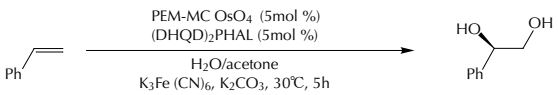
OsO_4 content : approx. 10 % (Fluorescent X-rays analysis)

IATA : Not restricted

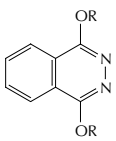
[Application]

PEM-based microencapsulated osmium (VIII) oxide is hydrophilic. Best applied when potassium ferricyanide ($K_3[Fe(CN)_6]$) is used as a cooxidant. When an asymmetric ligand is used, PEM- MC OsO_4 can be applied for asymmetric dihydroxylation reaction without the slow addition of olefins.

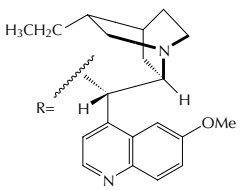
[Reaction]



Run	1	2	3
Yield of Product (%)	85	66	84
ee (%)	78	78	78
Recovery of Catalyst (%)	quant.	quant.	quant.



(DHQD)2PHAL



[References]

1) S. Kobayashi, M. Endo and S. Nagayama: *J. Org. Chem.*, **63**, 6094 (1998).
2) S. Kobayashi, T. Ishida and R. Akiyama: *Org. Lett.*, **3**, 2649 (2001).

Wako will perform contract services to supply microencapsulated osmium (VIII) oxide on an industrial scale and to synthesize diols and asymmetric diols.

(A. Microencapsulated Catalysts)

Sc Scandium Trifluoromethanesulfonate, Microencapsulated

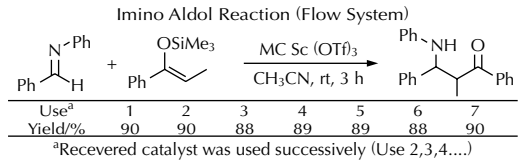
Cat. #196-12041 1 g
RT, Solid

[Features]
1. **Readily recoverable and reusable by filtration**
2. **Usable in both batch and flow system**
3. **Hardly any elution of Sc(OTf)3**

MW : 492.15 ($C_3F_9O_9S_3Sc$)
CAS : 144026-79-9
Appearance : White mass
$Sc(OTf)_3$ content : approx. 10 %
Scandium Trifluoromethanesulfonate ($Sc(OTf)_3$), a Lewis acid enabling to use water as a solvent for a wide range of organic reactions. Wako offers the polystyrene resin-supported catalyst based on the microencapsulation technique.

[Other Reactions]
1. By using imines : AzaDiels-Alder reaction, Cyanation reaction, Allylation reaction
2. Three-component condensation reaction : Mannich-type reaction, Strecher reaction
3. By using carbonyl compounds : Aldol reaction, Michael reaction, Cyanation reaction, Diels-Alder reaction

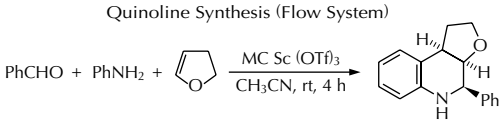
[Reaction 1]



Use[a]	1	2	3	4	5	6	7
Yield/%	90	90	88	89	89	88	90

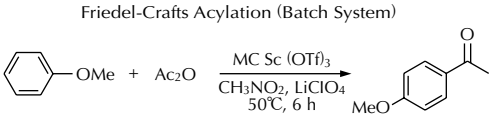
[a]Recevered catalyst was used successively (Use 2,3,4....)

[Reaction 2]



1st use, 68% yield ; 2nd use, 69% yield ; 3rd use, 69% yield

[Reaction 3]



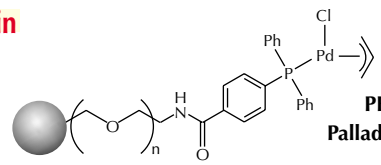
1st use, 76% yield ; 2nd use, 76% yield ; 3rd use, 81% yield

B. Palladium Catalysts

Pd Di-μ-chlorobis [(η-allyl) palladium (II)], Supported PEG-PS Resin

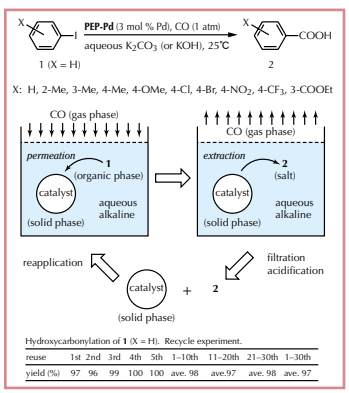
[PEG-PS resin-supported phosphine-Pd complex; PEP-Pd]

Cat. #043-27731 500 mg
2~10℃, Solid (yellow sticky mass)
Amphiphilic Resin-Supported Pd-Phosphine Catalyst

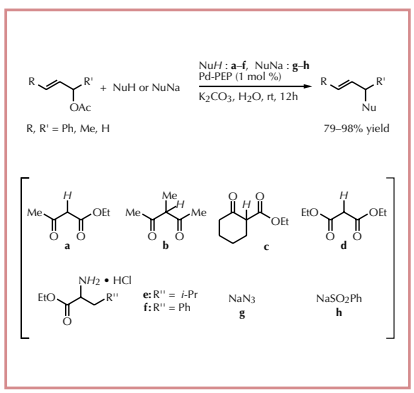


PEG-PS resin-supported Palladium-Phosphine Complex (Pd-PEP)

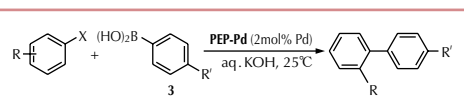
[Features]
1. **Readily recoverable and reusable by filtration for over 30 times**
2. **Amphiphillic resin-supported phosphine-palladium complex**
3. **Exhibits high catalytic activities in Tuji-Trost reaction, Suzuki-Miyaura cross-coupling reaction and Heck reaction in water by using PEP-Pd**

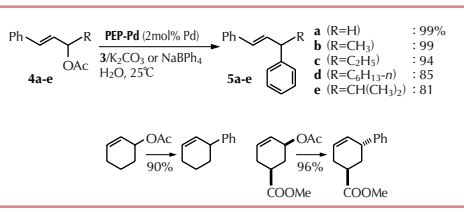


Hydroxycarbonylation of aryl halides in water catalyzed by PEP-Pd [2]



High catalytic activity of PEP-Pd in the allylic substitution in water [1]





Cross-coupling of aryl halides and ally acetates with arylboron reagents in water catalyzed by PEP-Pd [3]

[References]
1) Allylic substitution: (a)Uozumi, Y., Danjo, H., and Hayashi, T., *Tetrahedron Lett.*, **38**, 3557-3560 (1997), (b)Uozumi, Y., *et al.*, *Tetrahedron Lett.*, **39**, 8303-8306 (1998), (c)Danjo, H., *et al.*, *Tetrahedron*, **55**, 14341-14352 (1999).
2) Hydroxycarbonylation: Uozumi, Y., Watanabe, T., *J. Org. Chem.*, **64**, 6921-6923 (1999).
3) Cross-coupling: Uozumi, Y., *et al.*, *J. Org. Chem.*, **64**, 3384-3388 (1999).

Palladium (II)-Hydrotalcite (Pd : 1.5 %)

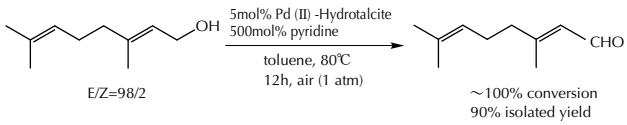
Cat. #161-20543 5 g
RT, Solid (pale yellow powder)

Palladium (II)-Hydrotalcite (m*) (Pd : 0.8%)

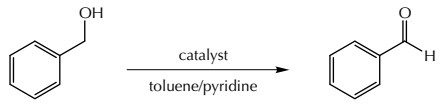
Cat. #168-20553 10 g
RT, Solid (pale yellow powder)
∗ m : modified

[Features]
1. **Pd(II)-hydrotalcite is a heterogeneous palladium catalyst that homogeneous palladium complex is immobilized on hydrotalcite ($Mg_6Al_2(OH)_{16}CO_3 \cdot H_2O$) which is a naturally produced basic clay mineral.**
2. **The noble immobilized Pd catalyst is found to be effective for the oxidation of a wide range of alcohols, using atmospheric oxygen or air.**
3. **In this catalytic system, various alcohols are readily converted to the corresponding aldehydes or ketones with high chemoselectivity or regioselectivity.**

[Reaction 1] Oxidation of Geraniol



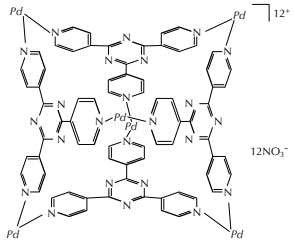
[Reaction 2] Pd(II)-Hydrotalcite in the Oxidation of Benzyl alcohol



[References]
1) T. Nishimura, N. Kakiuchi and S. Uemura: *Chem. Commun.***2000**, 1245-1246 (2000)
2) N. Kakiuchi, T. Nishimura, M. Inoue and S. Uemura: *Bull. Chem. Soc. Jpn.*, **74**, 165 (2001).

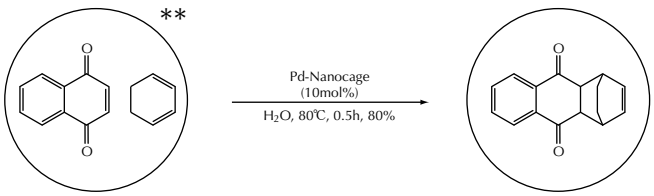
Palladium-Nanocage

Cat. #160-20471 1 g
RT, Solid (pale yellow powder)
MW : 2992.48 ($C_{84}H_{96}F_{48}O_{36}Pd_6$)
Pd-Nanocage which is self-assembled from(en)Pd$(NO_3)_2$ (as an adhesive) and triazine derivatives (as a molecular panel) is found to promote the aerobic, aqueous oxidation of styrene and its derivatives. It acts as a reverse phase-transfer catalyst, whereas $(en)Pd^{2+}$ as an oxidation catalyst.

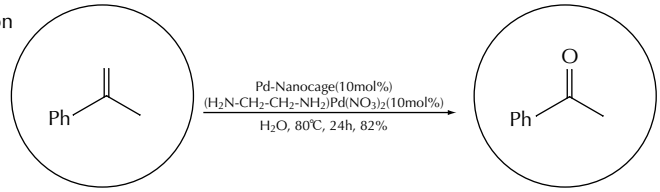


Pd=(H_2N-CH_2-CH_2-NH_2)Pd
Pd-Nanocage

[Reaction 1] Diels-Alder Reaction



[Reaction 2] Wacker Oxidation Reaction



∗∗ : ◯ shown in the above-mentioned chemical formulae shows the space of Nanocage.

[References]
1) D. Oguro, M. Miyazawa, H. Oka, K. Yamaguchi, K. Ogura, M.Fujita : *Nature*, **378**, 469 (1995).
2) T.Kusukawa, M. Fujita : *J. Am. Chem. Soc.*, **121**, 1397 (1999).
3) H. Ito, T. Kusukawa, M. Fujita : *Chem. Lett.*, 598 (2000).
4) M. Yoshizawa, T. Kusukawa, K. Yamaguchi, M. Fujita : *J. Am. Chem. Soc.*, **122**, 6311 (2000).

Tetrakis(triphenylphosphine) palladium (0), Supported PS Resin (Cat. #205-15561)……See page #4

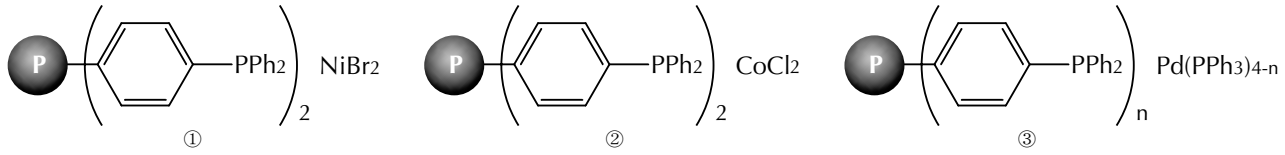
C. Triphenylphosphinated polystyrene complex

Catalyst made by fixing metals (Pd, Ni and Co) with the triphenylphosphine structure on polystyrene. This triphenylphosphine structure is bound not by a linker but in a form including the benzene ring of polystyrene. It is therefore relatively stable in various reactions.

[Features]

1. **Roughly homogeneous-sized particles with an average diameter of approximately 60μm, enabling efficient reaction**
2. **Readily recoverable and reusable by filtration**

[structural formula]



Product List

	Catalog No.	Product	Package Size	Content		Structure
Ni	042-28421	Dibromobis(triphenylphosphine)nickel (II), Supported PS Resin	500 mg	Ni : 0.87 mmol/g	2~10℃, Solid	①
Co	049-28431	Dichlorobis(triphenylphosphine)cobalt(II), Supported PS Resin	500 mg	Co : 0.95 mmol/g	2~10℃, Solid	②
Pd	205-15561	Tetrakis(triphenylphosphine)palladium(0), Supported PS Resin	500 mg	Pd : 0.07 mmol/g	2~10℃, Solid	③

2. Catalysts for Organic Synthesis in water

A. Rare-earth Triflate

Sc Scandium (III) Trifluoromethanesulfonate

Cat. #195-11391 1 g , #191-11393 5 g

RT, Solid (white~pale brown, crystalline powder~powder)

MW : 492.16 $(CF_3SO_3)_3Sc$

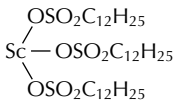
CAS : 144026-79-9

[References]

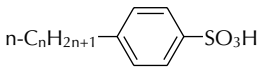
1) S. Kobayashi, I. Hachiya, M. Araki and H. Ishitani: *Tetrahedron Lett.*, **34**, 3755 (1993).
2) S. Kobayashi : *Synlett*, 689 (1994).

B. Surfactant Combined Catalysts

Organic reactions in water without use of damaging organic solvents are of great current interest from the standpoint of environmental or ecological concerns. The noble catalysts, which enable the use of water as a solvent for a wide range of organic reactions, will contribute to progress in environmentally benign chemical processes by reducing the use of organic solvents.



STDS



DBSA (n=10-14)

[Features] Immediately forming reaction substrates and emulsion in the water, realizing high-level hydrophobic condition

Sc

Scandium Tris (dodecyl sulfate) Trihydrate [STDS]

Cat. #194-12341 1 g
#190-12343 5 g

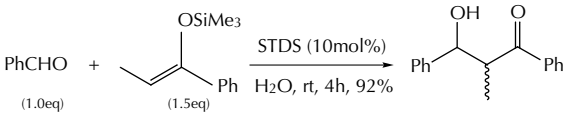
RT, Solid (white, powder)

MW : 895.17 ($Sc(OSO_3C_{12}H_{25})_3 \cdot 3H_2O$)

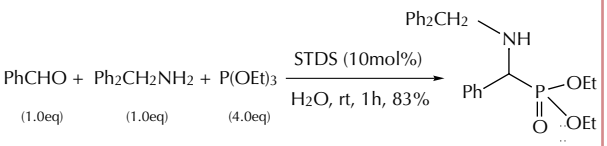
Assay (Titration) : 95.0+ %

STDS is a Lewis acid-surfactant combined compound. The newly designed Lewis acid has been shown to be a noble catalyst in the aldol reactions, Mannich-type reactions, allylation reactions and Michael reactions. It has very different characteristics from conventional Lewis acids. The stable dispersion systems including the catalyst and organic substrates are formed in water and highly water-sensitive ketene silyl acetals even react smoothly in the dispersion systems.

[Reaction 1] Aldol Reaction



[Reaction 2] Synthesis of α-Amino phosphonic acid



linear-Alkylbenzenesulfonic Acid [DBSA]

Cat. #017-15065 500 mL

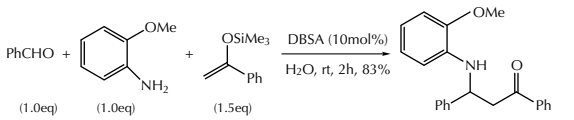
~25℃, protect from light, Liquid

[Class 8, UN 2584]

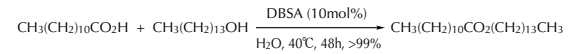
MW : 326.49 ($C_{18}H_{30}O_3S$)

DBSA is a Brønsted acid-surfactant combined compound and catalyzes efficiently three-components Mannich-type reaction of aldehydes, amines and silyl enolates in water. DBSA with the organic substrates forms stable colloidal particles in water and dehydrate reactions like an esterification can even be achieved in the colloidal particles.

[Reaction 1] Mannich Reaction



[Reaction 2] Esterification



[References]
1) K. Manabe, Y. Mori, T. Wakabayashi, S. Nagayama and S. Kobayashi : *J. Am. Chem. Soc.*, **122**, 7202 (2000).
2) T. Wakabayashi, S. Kobayashi : *Tetrahedron Lett.*, **39**, 5389 (1998).
3) K. Manabe, Y. Mori and S. Kobayashi : *Synlett.*, **9**, 1401 (1999).
4) K. Manabe, X-M. Mori, S. Kobayashi : *J. Am. Chem. Soc.*, **123**, 10101 (2001).

3. Solid Super-Acid Catalysts

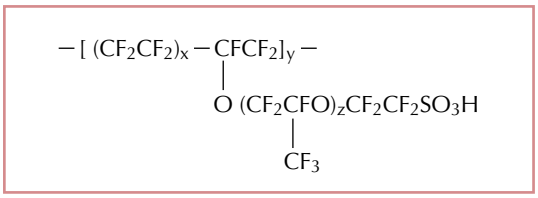
Solid Super-Acid Catalyst (A superacid is defined as any acid stronger than 100% sulfuric acid.)

[Features]

1. Low volatility and low toxicity
2. Readily recoverable and reusable without acidifying
3. No corrosion
(Since it does not corrode stainless steel, no special facilities such as glass lining equipment are required.)

Nafion® NR-50

Cat. #144-05991 5 g
#142-05992 25 g
RT, Solid (nealy white~brown, pellet)
CAS : 118473-68-0
Strong acid polymer in a bead form (perfluorinated ion exchange polymer : PFIEP), which can be applied for a wide range of organic reactions requiring an acid catalysis.



Nafion® is a registered mark of DuPont.

[How to recycle]

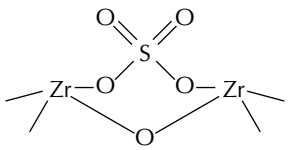
1. Boil for two hours in 150 mL of H_2O, followed by filtration
2. Add the resin that is obtained after filtration to 200 mL of 20~25% nitric acid, and agitate it for 4~5 hours at a room temperature. Then filter it.
3. Repeat nitric acid treatment several times.
4. Rinse the resin that has been treated with acid with distilled water until the water becomes neutral.
5. Dry the rinsed resin for 24 hours at a temperature of 100~105℃.

[References]

1) S. Kanemoto, H. Saimoto, K. Oshima, H. Nozaki : *Tetrahedron Lett.*, **25**, 3317 (1984).
2) M. Hino, K. Arata : *Apple. Catol.*, **18**, 401 (1985).

Zr Zirconia, Sulfated [Sulfated Zirconia]

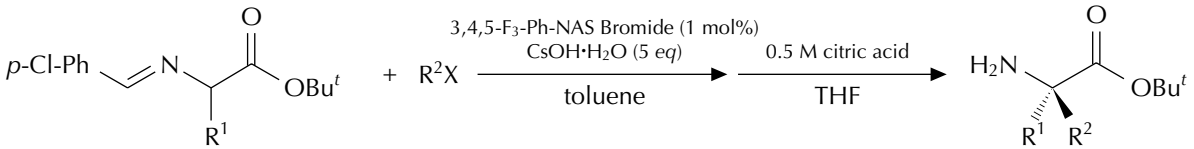
Cat. #269-01471 5 g
#267-01472 25 g
RT, Solid (white, powder)
Zirconium content : 60~70 %
Metal oxide superacid obtained by burning metal oxide whose surface has been coated with sulfate ion, at a temperature of about 500-600℃ in the air.
Act as a heterogeneous catalyst well in isomerization of saturated hydrocarbon, Friedel-Crafts-type acylation reaction and other reactions.



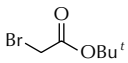
(presumed)

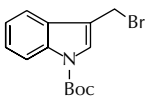
4. Chiral Phase-Transfer Catalysts (PTC)

Chiral Phase-Transfer Catalysts (PTC)



Catalytic Enantioselective Synthesis of α, α-Dialkyl-α-amino Acids by Phase-Transfer Alkylation

entry	R^1	R^2X	condition (℃, h)	% isolated yield	% ee (config)
1	Me	$PhCH_2Br$	0, 0.5	85	98 (*R*)
2			0, 0.5	73	98 (*R*)
3		EtI^e	0, 0.3	71	99 (*R*)
4			-20, 2	60	93 (*R*)

entry	R^1	R^2X	condition (℃, h)	% isolated yield	% ee (config)
5			-10, 0.7	78	91 (*R*)
6	$PhCH_2$		0, 0.5	71	97 (*S*)
7	*i*-Bu	$PhCH_2Br$	0, 0.5	64	92
8			0, 1	70	93

Coming Soon!

(*R,R*)-3,5-Bistrifluoromethylphenyl-NAS Bromide ①

[Maruoka Catalyst RR-Bistrifluoromethylphenyl Br Form]

Cat. #029-14921 100 mg
#025-14923 500 mg

RT

MW : 1078.82 ($C_{60}H_{36}BrF_{12}N$)

Coming Soon!

(*R,R*)-3,4,5-Trifluorophenyl-NAS Bromide ②

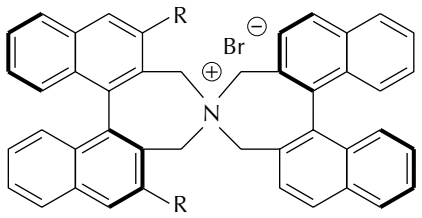
[Maruoka Catalyst RR-Trifluorophenyl Br Form]

Cat. #201-15921 100 mg
#207-15923 500 mg

RT

MW : 914.77 ($C_{56}H_{34}BrF_6N$)

CAS : 287384-12-7



① (R=3,5-Bistrifluoro-Ph), ② (R=3,4,5-F_3-Ph)

[References]

1) Ooi T., Takeuchi M., Kameda M. and Maruoka K.: *J. Am. Chem. Soc.*, **122** (21), 5228-5229 (2000).
2) Ooi T., Taniguchi M., Kameda M., Maruoka K. : *Angew. Chem. Int.*

[Features]

1. **The rational molecular design of C_2-symmetric chiral quaternary ammonium salt**
2. **Reaction under mild organic / aqueous biphase conditions**
3. **Catalyzing the asymmetric alkylations of α-amino acid derivatives and the direct asymmetric aldol reactions of glycine schiff base with aldehydes to the corresponding β-hydroxy-α-amino acid derivatives**

5. Ionic Liquid

Ionic liquid is quaternary ammonium salt with low melting point and high boiling point. With its high stability at from high to low temperatures.

[Features]

1. **Nonvolatile liquid**
2. **Having low-viscosity although the liquid is ionic**
3. **Heat resistant and with wide liquid temperature range**
4. **Easy to collect and recycle because of its non-miscibility with organic solvent**

Coming Soon!

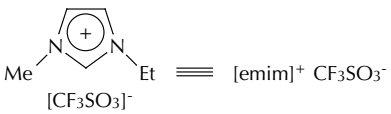
1-Ethyl-3-methylimidazolium Trifluoromethanesulfonate

Cat. #059-07111 10 g

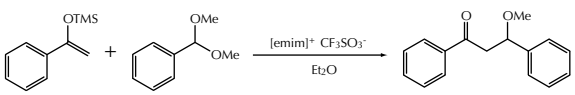
RT, Liquid (pale brown, liquid)

MW : 260.23 ($C_7H_{11}F_3N_2O_3S$)

CAS : 145022-44-2



[Reaction 1] Aldol Reaction



yield : 84%

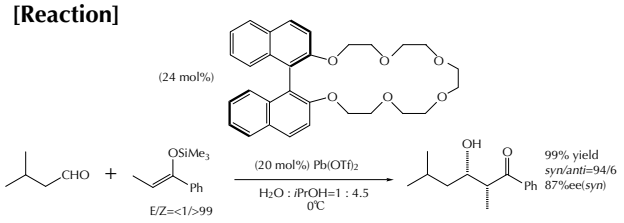
A. Chiral Crown Ethers

Chiral crown ether, which forms complexes with free metals in water solution, has turned out to be an effective asymmetric ligand for catalytic asymmetric synthesis reaction.

[References]

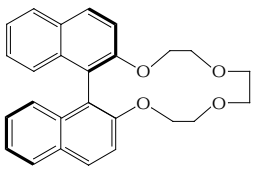
S. Nagayama, S. and S. Kobayashi : *J. Am. Chem. Soc.*, **122**, 11531 (2000).

[Reaction]



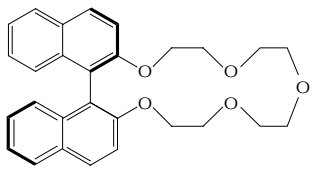
(*R*)-2,2'-Binaphthyl-14-crwon-4

Cat. #023-14681 1 g
RT, Solid (pale brown, powder)
CAS : 128778-82-5



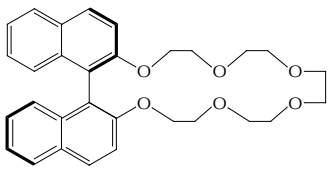
(*R*)-2,2'-Binaphthyl-17-crwon-5

Cat. #023-14701 1 g
RT, Solid (pale yellow, powder)
CAS : 99630-51-0



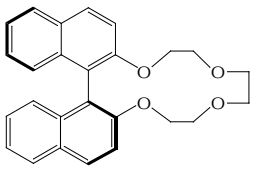
(*R*)-2,2'-Binaphthyl-20-crwon-6

Cat. #027-14721 1 g
RT, Solid (colorless, viscous mass)
CAS : 75684-69-4



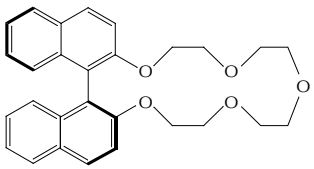
(*S*)-2,2'-Binaphthyl-14-crwon-4

Cat. #020-14691 1 g
RT, Solid (pale yellow, powder)
CAS : 55442-00-7



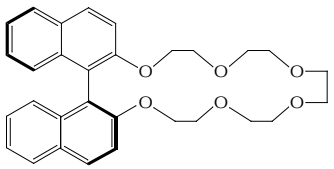
(*S*)-2,2'-Binaphthyl-17-crwon-5

Cat. #020-14711 1 g
RT, Solid (nearly pale yellow, powder)
CAS : 55442-01-8



(*S*)-2,2'-Binaphthyl-20-crwon-6

Cat. #024-14731 1 g
RT, Solid (colorless, viscous mass)
CAS : 41024-92-4

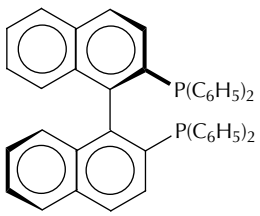


〈MW : 400.47 ($C_{26}H_{24}O_4$)〉 〈MW : 444.52 ($C_{28}H_{28}O_5$)〉 〈MW : 488.57 ($C_{30}H_{32}O_6$)〉

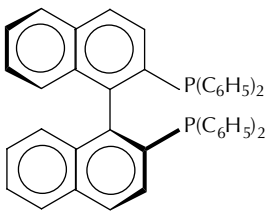
WAKO PRODUCT UPDATE

B. Ligands for Catalytic Asymmetric Synthesis: BINAP

BINAP is one of the most frequently used chiral phosphine compounds, which is used for acymmetric synthesis using various kinds of metal catalysts.



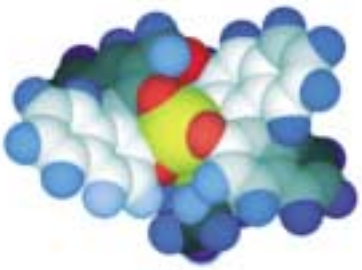
(*R*)-BINAP



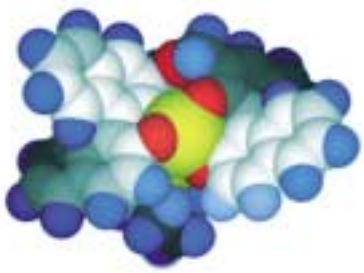
(*S*)-BINAP

Wako Catalog No.	Product	Package Size	MW	CAS	Assay	Apperance	Storage
029-14301 025-14303 027-14302	**(*R*)-(+)-2,2'-Bis(diphenylphosphino)-1,1'-binaphthyl** [(*R*)-(+)-BINAP]	1 g 5 g 25 g	622.67 ($C_{44}H_{32}P_2$)	76189-55-4	97.0+% (HPLC)	Solid	RT
026-14311 022-14313 024-14312	**(*S*)-(-)-2,2'-Bis(diphenylphosphino)-1,1'-binaphthyl** [(*S*)-(-)-BINAP]	1 g 5 g 25 g	622.67 ($C_{44}H_{32}P_2$)	76189-56-5		Solid	RT

C. Ligands for Asymmetric Two-Center Catalysis : linked-BINOL

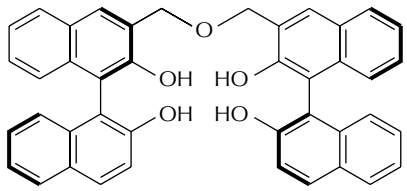


(*R,R*)-Ga-Li-linked-BINOL



(*S,S*)-Ga-Li-linked-BINOL

The molecule models of Ga-Li-linked BINOL by X-ray crystal structure analysis



(*S,S*)-linked-BINOL

[Features]

Ligands for direct catalytic asymmetric aldol reaction with unmodified ketones and for the catalytic asymmetric Michael reaction

3,3"-[Oxybis(methylene)] bis-(*1R,1"R*)-1,1'-bi-2-naphthol

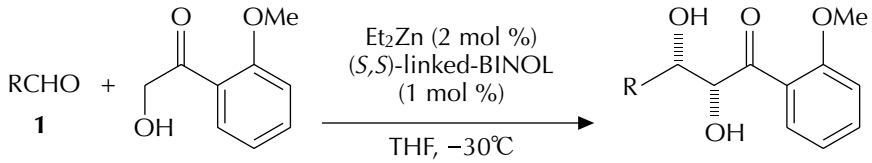
[(*R,R*)-linked-BINOL]

Cat. #155-02421 200 mg
RT, Solid (yellow, powder)
MW : 614.68 ($C_{42}H_{30}O_5$)
CAS : 265116-85-6
Assay (HPLC) : 90.0+ %

3,3"-[Oxybis(methylene)] bis-(*1S,1"S*)-1,1'-bi-2-naphthol

[(*S,S*)-linked-BINOL]

Cat. #152-02431 200 mg
RT, Solid (yellow, powder)
MW : 614.68 ($C_{42}H_{30}O_5$)
CAS : 336800-79-4
Assay (HPLC) : 95.0+ %



entry	aldehyde		time (h)	yield (%)	dr *(syn/anti)*	ee *(syn/anti)*
1	Ph⁄⁄CHO	**1a**	20	94	89/11	92/89
2	⁄⁄⁄⁄CHO	**1b**	18	88	88/12	95/91
3	⁄⁄⁄⁄⁄⁄CHO	**1c**	18	84	87/13	96/87
4	⁄CHO	**1d**	18	84	84/16	93/87
5	⁄⁄CHO	**1e**	24	94	86/14	87/92

entry	aldehyde		time (h)	yield (%)	dr *(syn/anti)*	ee *(syn/anti)*
6	BnO⁄⁄CHO	**1f**	18	81	86/14	95/90
7	BnO⁄⁄⁄CHO	**1g**	16	84	72/28	96/93
8	⁄CHO	**1h**	24	83	97/3	98/—
9	⁄⁄CHO	**1i**	16	92	96/4	99/—
10	⁄CHO	**1j**	18	95	97/3	98/—

[References]

1) Shibasaki M. and Kanai M.: *Chem. Pharm. Bull. (Tokyo)*, **49**(5), 511-24 (2001).
2) Kumagai N., Matsunaga S., Yoshikawa N., Ohshima T. and Shibasaki M.: *Org. Lett.*, **3**(10), 1539-42 (2001).
3) Shibasaki M., Kanai M. and Funabashi K.: *Chem. Commun. (Camb)*, **21**(18), 1989-99 (2002).

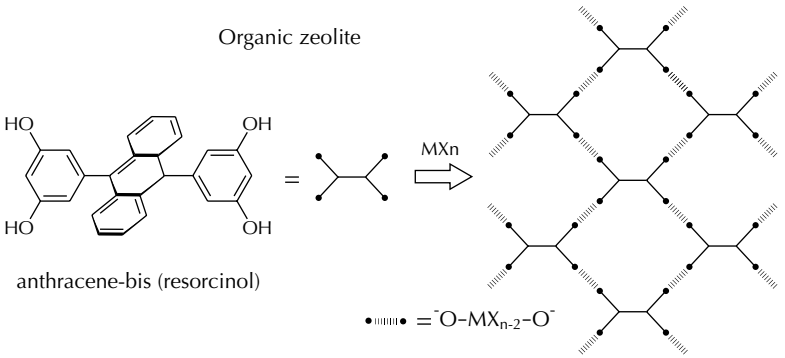
D. Unique Catalytic Materials

Organic zeolite is formed from anthracenebis- resorcinol with metal alkoxides such as La(OPr-*i*)$_3$ or Zr(OBu-*t*)$_4$ based on hydrogen- bonded network. Pd-Nanocage is self-assembled from (en)Pd(NO$_3$)$_2$ (as an adhesive) and triazine derivatives (as a molecular panel).

These unique materials are usefully effective catalysts for the organic reactions in aqueous medium. For example, the Diels-Alder reaction, Wacker oxidation, Michael reaction and nitroaldol reaction are accelerated in water by using these catalysts. These catalytic performances are caused by the function of metal and hydrophobic space containing their inner.

Anthracene-9,10-bis (5-resorcinol)

Cat. #018-18851 100 m g
#014-18853 1 g
RT, Solid (pale yellow, powder)
MW : 394.42 ($C_{26}H_{18}O_4$)
CAS : 153715-08-3
Assay (HPLC) : 98.0 + %



Palladium-Nanocage (Cat. #160-20471) ···See page #3

[References]

1) a) S. Kobayashi, T. Wakabayashi; Tetrahedron Lett., 39, 5389 (1998).
b) K. Manabe, Y. Mori, T. Wakabayashi, S. Nagayama, S. Kobayashi; *J. Am. Chem. Soc.*, **122**, 7202 (2000).
2) a) K. Manabe, Y. Mori, S. Kobayashi: *Synlett.*, 1401 (1999).
b) K. Manabe, Y. Mori, S. Kobayashi: *Tetrahedron*, **57**, 2537 (2001).
3) a) T. Kusukawa, M. Fujita; *Shokubai*, **42**, 564 (2000).
b) H. Ito, T. Kusukawa, M. Fujita; *Chem. Lett.*, 598 (2000).
4) a) Y. Uozumi, H. Danjo, T. Hayashi: *Tterahedron Lett.*, **38**, 3557 (1997).
b) Y. Uozumi, H. Danjo, T. Hayashi: *J. Org. Chem.*, **64**, 3384 (1999).
c) Y. Uozumi, T. Watanabe; *J. Org. Chem.*, **64**, 6921 (1999).

Histochemistry

Xylene Substitutes

Lemosol® A and Lemosol® are aromatic solvents used as xylene substitutes for cleaning and deparaffinizing steps in staining and tissue processing.

[Features]
- **Far less toxic than xylene**
- **The volatilization is equal to that of xylene.**

Lemosol® A

120-04411 1L
126-04413 3L
128-04417 18L
protect from light, Liquid
Flash point : 36.5℃
LD_{50} (rat, oral) : 5g/kg
Terpenes based solvent derived from bark of eucalyptus and pine.
The main ingredient is pinene.

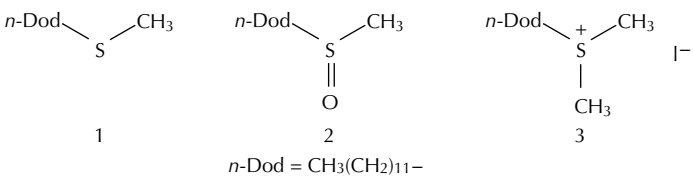
Lemosol®

122-03991 1L
128-03993 3L
120-03997 18L
RT, Liquid
Limonene-based solvent derived from citrus.

7. Sulfur Compounds with Less Odor

This sulfur compound with less odor is made by replacing one of alkyl chains bound to a sulfur atom by a dodecyl radical. It has less volatility and smells less disagreeable. It is applicable to alcohol oxidation reaction, such as dealkylation of ether and ester, Corey-Kim oxidation and Swern oxidation. Sulfonium salt can also be used as a methylation agent for oxirane synthesis.

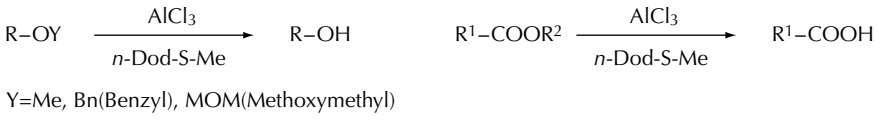
[Chemical Structures]



1 2 3

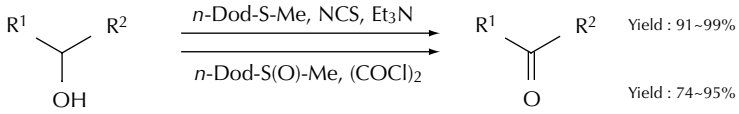
n-Dod = $CH_3(CH_2)_{11}$–

[Reaction 1]



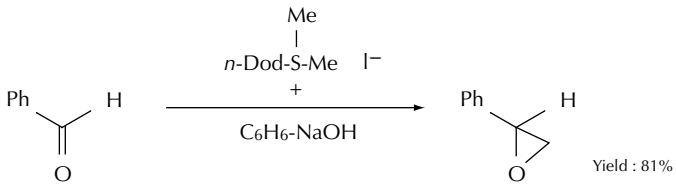
Y=Me, Bn(Benzyl), MOM(Methoxymethyl)

[Reaction 2]



NCS=*N*-chlorosuccinimide

[Reaction 3]



Wako Catalog No.	Product	Package Size	MW	CAS	Appearance	Storage
040-28581	**Dodecyl Methyl Sulfide**	10 g	216.43 ($C_{13}H_{28}S$)	3698-89-3	liquid	2~10℃
047-28591	**Dodecyl Methyl Sulfoxide**	10 g	232.43 ($C_{13}H_{28}OS$)	3079-30-9	white, powder	2~10℃
040-28601	**Dodecyldimethylsulfonium Iodide**	10 g	358.37 ($C_{14}H_{31}IS$)	18412-81-2	pale yellow, powder	2~10℃

[References]

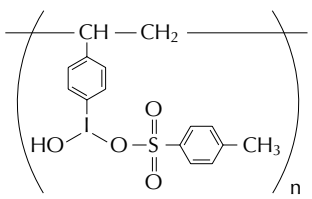
1) K. Nishide, S. Ohsugi, H. Shiraki, H. Tamakita and M. Node: *Org. Lett.*, **3**, 3121-3124 (2001)
2) M. Node, K. Kumar, K. Nishide, S. Ohsugi and T. Miyamoto: *Tetrahedron Lett.*, **42**, 9207-9210 (2001)
3) Y. Yano, T. Okonogi, M. Sunaga and W. Tagaki: *J. Chem. Soc. Chem. Commun.*, 527-528 (1973)
4) K. Yamauchi, Y. Hisanaga and M. Kinoshita: *J. Am. Chem. Soc.*, **105**, 538-545 (1983)
5) K. Yamauchi, Y. Hisanaga and M. Kinoshita: *J. Chem.Soc., Perkin Trans.*, **1**, 1941-1942 (1983)

8. Reagent for Polymer-supported Tosyloxylation Reaction

Poly [*p*-(hydroxy) (tosyloxy) iodostyrene]

Cat. #163-20461 500 mg
-20℃, Solid

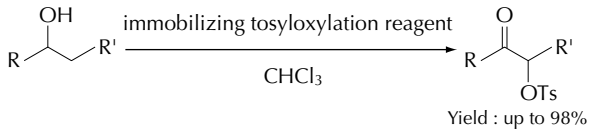
Molecular Formula : $-[C_{15}H_{15}IO_4S]_n-$



[Features]

1. **For oxidative α-tosyloxylation of alcohols, α-tosyloxylation of ketones and oxidative α-tosyloxylation of alkynes**
2. **Readily isolated from the reaction mixture by filtration**

[Reaction]



Yield : up to 98%

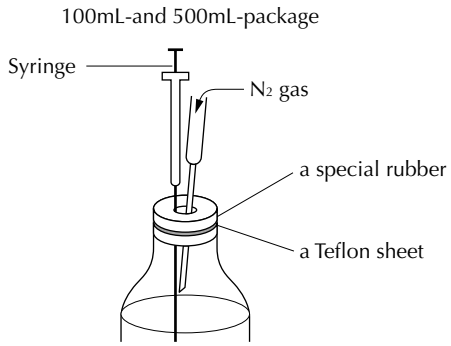
Oxidative α-tosyloxylation of alcohols

[References]

1) H. Togo and K. Sakuratani: *Synlett*, 1966 (2002)
2) S. Abe, K. Sakuratani and H. Togo: *Synlett*, 22 (2001)
3) S. Abe, K. Sakuratani and H. Togo: *J. Org.* Chem., **66**, 6174 (2001)

9. Dehydrated Solvents

Solvent for organic synthesis, containing its water content to its minimum. Can be used as a solvent for various organic synthesis reactions where water should be avoided. Each 100mL-and 500 mL-package has a special cap through which a syringe needle can be inserted. As shown in the figure, the solvent is collected while blowing nitrogen gas into a package.



Product Name	Water content	Package Size			Class	UN	Storage
		100 mL	500 mL	3 L			
Acetone, Dehydrated (99.5+ %)	max. 50 ppm	010-15533	016-15535	014-15531	3	1090	Protect from light
Acetonitrile, Dehydrated (99.0+ %)	max. 50 ppm	017-15543	013-15545	011-15541	3	1648	RT
Benzene, Dehydrated (99.5+ %)	max. 30 ppm	022-12853	028-12855	026-12851	3	1114	RT
1-Butanol, Dehydrated (99.0+ %)	max. 50 ppm	-	020-13035	028-13031	3	1120	RT
2-Butanone, Dehydrated (99.0+ %)	max. 50 ppm	-	027-13045	025-13041	3	1193	Protect from light
Butyl Acetate, Dehydrated (99.0+ %)	max. 50 ppm	027-13263	023-13265	-	3	1123	RT
Chloroform, Dehydrated, containing 0.3 ~ 1.0 % of Ethanol (99.0+ %)	max. 30 ppm	035-16283	031-16285	039-16281	6.1	1888	RT
Chloroform, Dehydrated, containing 150 ppm of Amylene (99.0+ %)	max. 30 ppm	032-16813	038-16815	036-16811	6.1	1888	RT
Cyclohexane, Dehydrated (99.5+ %)	max. 30 ppm	-	036-16595	034-16591	3	1145	RT
Dichloromethane, Dehydrated (99.0+ %)	max. 30 ppm	048-25503	044-25505	042-25501	6.1	1593	Protect from light
Diethyl Ether, Dehydrated (99.5+ %)	max. 50 ppm	-	041-25495	-	3	1155	Protect from light
***N,N*-Dimethylacetamide, Dehydrated** (98.0+ %)	max. 50 ppm	-	042-25285	040-25281	-	-	RT
***N,N*-Dimethylformamide, Dehydrated** (99.5+ %)	max. 50 ppm	041-25473	047-25475	045-25471	3	2265	Protect from light
Dimethyl Sulfoxide, Dehydrated (99.0+ %)	max. 50 ppm	046-26023	042-26025	-	-	-	RT
1,4-Dioxane, Dehydrated (99.0+ %)	max. 50 ppm	-	044-25485	042-25481	3	1165	RT
Ethanol, Dehydrated (99.5+ %)	max. 50 ppm	055-06133	051-06135	059-06131	3	1170	RT
Ethyl Acetate, Dehydrated (99.5+ %)	max. 50 ppm	050-06183	056-06185	054-06181	3	1173	RT
Ethylene Glycol, Dehydrated (99.5+ %)	max. 50 ppm	053-06313	059-06315	-	-	-	RT
Heptane, Dehydrated (99.0+ %)	max. 30 ppm	089-07273	085-07275	-	3	1206	RT
Hexane, Dehydrated (96.0+ %)	max. 30 ppm	089-07033	085-07035	083-07031	3	1208	RT
Methanol, Dehydrated (99.8+ %)	max. 50 ppm	136-12383	132-12385	130-12381	3 & 6.1	1230	RT
4-Methyl-2-pentanone, Dehydratede	max. 50 ppm	131-12713	137-12715	-	3	1245	Protect from light
1-Methyl-2-pyrrolidone, Dehydrated (97.0+ %)	max. 50 ppm	138-12723	134-12725	-	-	-	RT
1-Propanol, Dehydrated (99.5+ %)	max. 50 ppm	-	166-18305	164-18301	3	1274	RT
2-Propanol, Dehydrated, containing Iso-propanol (99.5+ %)	max. 50 ppm	165-17993	161-17995	169-17991	3	1219	RT
Pyridine, Dehydrated (99.5+ %)	max. 50 ppm	161-18453	167-18455	165-18451	3	1282	RT
Tetrahydrofuran, Dehydrated, containing 0.03% BHT (99.5+ %)	max. 50 ppm	206-13433	202-13435	200-13431	3	2056	Protect from light
Tetrahydrofuran, Dehydrated, containing no stabilizer (99.5+ %)	max. 50 ppm	207-13963	203-13965	201-13961	3	2056	Protect from light
Toluene, Dehydrated (99.5+ %)	max. 30 ppm	203-13443	209-13445	207-13441	3	1294	RT
Xylene, Dehydrated (80+ %) (mixture of *o*-, *m*- and *p*-Xylene)	max. 30 ppm	-	242-00685	240-00681	3	1307	RT

Chromato Sheet

Cat. #036-17151 25 sheets
RT

Chromato sheet is an environment-friendly product, making full use of advantages of "paper." It is light, easy to use and disposable with no damage to environment.
Unlike a conventional thin-layer chromatoplate (TLC plate), this is made from paper fiber which is coated with silica gel and fluorescent F254. This product provides usability of paper and separabiltiy of silica gel (adsorption/partition mode).

[Features]
1. **High resolution & reproducibility**
2. **Clipping, Wiring and Filing as a paper**
3. **Meet no-detached silica gel powder**
4. **Applicable to blotting**
5. **Applicable to fluorometric detection**

Left : Chromato Sheet
Right : Silicagel 70F_{254} Plate-wako
Sample : Wakogel B-Tester (#231-00051)
Developing solvent : Chloroform

[Specification]
Size : 20 × 20 cm
Weight : Approximately 7 g/sheet
Thickness : 0.3 mm
Silica gel : Wakogel C-500HG containing F254 fluorescent Indicator.

Detection at 254 nm
Sample : Brucine, oxypropyltheophylline and caffein
Developing solvent : Chloroform(9) + Methanol(1)

[Limitation]
Inapplicable to use color-producing reagents containing strong acids and to treat carbonization by heating at a high temperature

ALPHABETICAL INDEX

- Please visit our online catalog to search for other products from Wako ; **http://search.wako-chem.com**
- This brochure may contain products that cannot be exported to your country due to regulations.
- Bulk quote requests for some products are welcomed. Please contact us.

03115IBK

Wako Pure Chemical Industries, Ltd.

1-2, Doshomachi 3-Chome
Chuo-Ku, Osaka 540-8605, Japan
Telephone :+81-6-6203-3741
Facsimile :+81-6-6201-5964
Online Cat. : http://search.wako-chem.com

Wako Chemicals USA, Inc.

1600 Bellwood Road
Richmond, VA 23237, U.S.A.
Toll-Free (U.S. only) : +1-877-714-1920
Telephone :+1-804-714-1920
Facsimile :+1-804-271-7791
http://www.wakousa.com

Wako Chemicals GmbH

Nissanstraße 2, D-41468
Neuss, Germany
Telephone :+49-(0)2131-311-0
Facsimile :+49-(0)2131-311100
E-mail : biochem@wako-chemicals.de