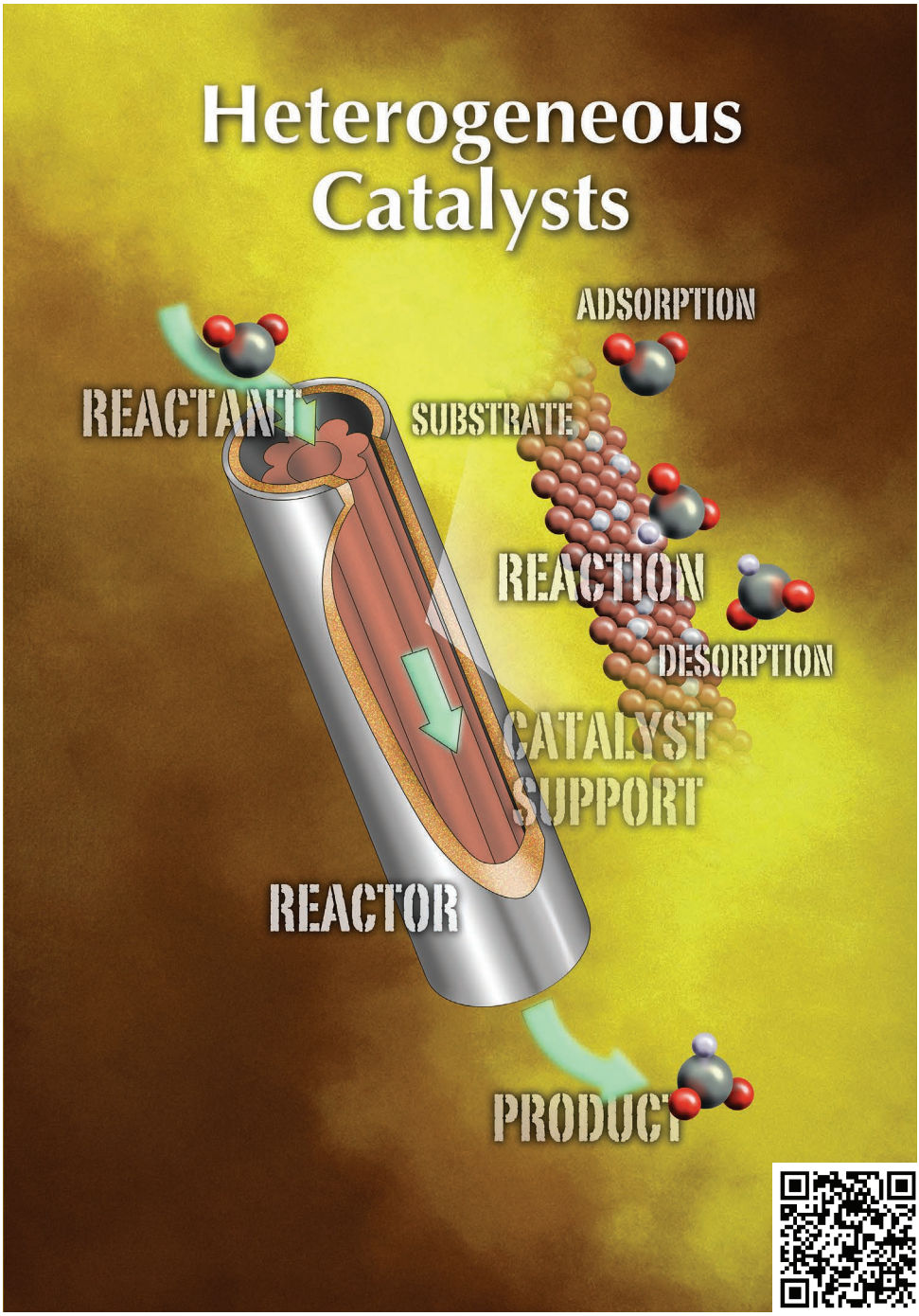
Heterogeneous Catalysts
ADSORPTION
REACTANT
SUBSTRATE
REACTION
DESORPTION
CATALYST SUPPORT
REACTOR
PRODUCT

Heterogeneous Catalysts

Strem Chemicals has been providing metal catalysts for research and fine chemical production for over fifty years. Our metal catalyst product family includes heterogeneous, homogeneous and immobilized catalysts as well as catalyst supports. This booklet focuses on our heterogeneous and immobilized catalyst products. We also offer related kits, which can be found at the back of the booklet.

At Strem, we also offer a wide variety of ligands, nanomaterials and CVD/ALD precursors. Most of our products are of high purity, typically at 99%, while some are as high as 99.9999% metals purity. As an effort to expand our product line, we continually seek to provide new technologies from around the globe. We have licensing agreements with industry and academia, which allow easier access to these patent-protected products for our customers. We look forward to continued growth in order to best serve our customers' needs with the quality and service they can trust from Strem.

As part of our ongoing commitment to quality, we have achieved ISO 9001 certification for the Quality Management System (QMS) at our corporate headquarters in Newburyport, Massachusetts.

In addition, custom synthesis services are provided on a contract basis. For pharmaceutical applications, manufacturing is conducted under current Good Manufacturing Practices (cGMP) in FDA inspected kilo-lab suites. Complete documentation is available, including validation and stability studies. Active Drug Master Files (DMF's) are maintained in North America and Europe.

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Our other booklets, which focus on applications and product classes, are available in print per request and also on our website. Below is a list of current booklet titles that are available. Please also check our Product Resources section online to find additional literature offerings, such as the Strem Chemiker, our technical publication, and product literature sheets.

- Buchwald Ligands and Precatalysts
- Gold Elements & Compounds
- Heterogeneous Catalysts
- Kits
- Materials for Energy Applications
- Metal Catalysts for Organic Synthesis
- MOCVD, CVD & ALD Precursors
- Nanomaterials
- New Products
- Other Ligands
- Phosphorous Ligands and Compounds
- PURATREM: High Purity Inorganics

Ephraim S. Honig, Ph.D., M.B.A
Chief Executive Officer

ISO 9001 CERTIFIED

HC 06/17

Glossary of Terms

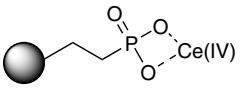
$[\alpha]_D$	.....	Specific rotation
AAS	.....	Atomic Absorption Standard
ACS	.....	Conforms to American Chemical Society specifications
air sensitive	.....	Product may chemically react with atmospheric oxygen or carbon dioxide at ambient conditions. Handle and store under an inert atmosphere of nitrogen or argon.
amp	.....	Ampouled
b.p.	.....	Boiling point in °C at 760mm, unless otherwise noted
d.	.....	Density
dec.	.....	Decomposes
elec. gr.	.....	Electronic Grade, suitable for electronic applications
f.p.	.....	Flash point in °F
gran.	.....	Granular
heat sensitive	.....	Product may chemically degrade if stored for prolonged periods of time at ambient temperatures or higher. Store at 5°C or lower.
hydrate	.....	Unspecified water content which may vary slightly from lot to lot
hygroscopic	.....	Product may absorb water if exposed to the atmosphere for prolonged periods of time (dependent on humidity and temperature). Handle and store under an inert atmosphere of nitrogen or argon.
light sensitive	.....	Product may chemically degrade if exposed to light
liq.	.....	Liquid
m.p.	.....	Melting point in °C
moisture sensitive	.....	Product may chemically react with water. Handle and store under an inert atmosphere of nitrogen or argon.
NMR grade		Suitable as a Nuclear Magnetic Resonance reference standard
optical grade	.....	For optical applications
pwdr.	.....	Powder
primary standard	.....	Used to prepare reference standards and standardize volumetric solutions
PURATREM	.....	Product has a minimum purity of 99.99% (metals basis)
purified	.....	A grade higher than technical, often used where there are no official standards
P. Vol.	.....	Pore volume
pyrophoric	.....	Product may spontaneously ignite if exposed to air at ambient conditions
reagent	.....	High purity material, generally used in the laboratory for detecting, measuring, examining or analyzing other substances
REO	.....	Rare Earth Oxides. Purity of a specific rare-earth metal expressed as a percentage of total rare-earths oxides.
SA	.....	Surface area
store cold	.....	Product should be stored at -18°C or 4°C, unless otherwise noted (see product details)
subl.	.....	Sublimes
superconductor grade	.....	A high purity, analyzed grade, suitable for preparing superconductors
tech. gr.	.....	Technical grade for general industrial use
TLC	.....	Suitable for Thin Layer Chromotography
v.p.	.....	Vapor pressure mm of Hg
xtl.	.....	Crystalline

About Purity

Chemical purity	.....	is reported after the chemical name, e.g. Ruthenium carbonyl, 99%
Metals purity	.....	is reported in parentheses with the respective element, e.g. Gallium (III) bromide, anhydrous, granular (99.999%-Ga) PURATREM where 100% minus the metal purity is equal to the maximum allowable percentage of trace metal impurity

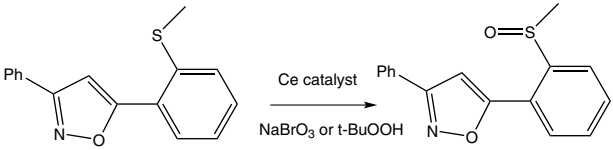
CERIUM (Compounds)

58-5100 **Cerium(IV) ethyl/butyl phosphonate Silica (PhosphonicS POCe)** 5g 25g
yellow solid; SA: >350 m²/g
Note: Sold in collaboration with PhosphonicS Ltd. for research purposes only. PhosphonicS Metal Oxidation Catalyst Kit component.



Particle size range: 70-200 microns
Average pore size: 60Å
Effective loadings: 0.3 to 0.5 mmol/g

Technical Note:
1. Catalyst used for the oxidation of a range of sulfides to sulfoxides.

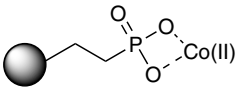


References:
1. *Tetrahedron Lett.,* **2005**, *46*, 4365

96-6770 **PhosphonicS Metal Oxidation Catalyst Kit**
See page 23

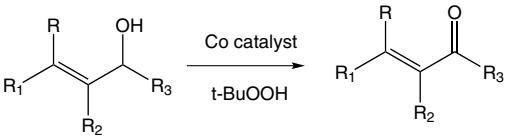
COBALT (Compounds)

27-0900 **Cobalt(II) ethyl/butyl phosphonate Silica (PhosphonicS POCo)** 5g 25g
blue solid; SA: >350 m²/g
Note: Sold in collaboration with PhosphonicS Ltd. for research purposes only. PhosphonicS Metal Oxidation Catalyst Kit component.

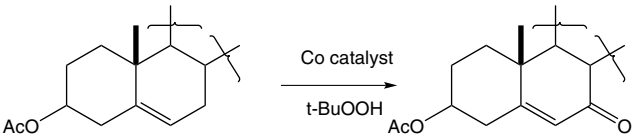


Particle size range: 70-200 microns
Average pore size: 60Å
Effective loadings: 0.3 to 0.5 mmol/g

Technical Note:
1. Catalyst used for oxidation of a wide variety allylic alcohols and alkene substrates, including complex steroids.



Tech. Note (1)
Ref. (1)



Tech. Note (1)
Ref. (2)

References:
1. *Tetrahedron Lett.,* **2004**, *45*, 4465
2. *Tetrahedron Lett.,* **2003**, *44*, 4283

27-0480 **Cobalt oxide-molybdenum oxide on alumina (3.5% CoO, 14% MoO_3)** 100g 500g
(1308-06-1)
1/8" extrusions; SA: ~244m²/g

COBALT (Compounds)

96-6770 **PhosphonicS Metal Oxidation Catalyst Kit**
See page 23

COPPER (Elemental Forms)

29-2760	**Sponge copper catalyst (Raney®-type)** *(7440-50-8)*	25g
HAZ	50% aqueous slurry	100g
	air sensitive	500g

COPPER (Compounds)

25-2900 **Carulite® Catalyst** *(185036-38-8)*
See page 3

29-0410 **Copper chromite, barium promoted (62-64% Cr_2CuO_4, 22-24% CuO, 6%BaO, 0-4% Graphite, 1% CrO_3, 1% Cr_2O_3)** *(12018-10-9)* 100g 500g
CuO/Cr_2CuO_4; FW: 79.55/231.53; black pellets; SA: 45-50 m^2/g

GOLD (Elemental Forms)

79-0160 **Gold 1% on aluminum oxide extrudates (AUROlite™ Au/Al_2O_3)** 10g 50g
(7440-57-5)
dark purple extrudates ~1.2mm dia. x 5mm (avg)
(store cold)
Note: Sold in collaboration with Project AuTEK for research purposes. Reverse engineering and product modification prohibited. Only open before use, store cold in dark. See web for more details.

Analysis: Au 1 wt% ± 0.1%; Al_2O_3 98 wt%; Na+, Cl- <1500ppm
Bulk density: 0.6–0.8 g/ml

Technical Note:
1. Useful product for the catalytic oxidation of a variety of substrates including carbon monoxide, aldehydes, alkenes, methane and ethanol. Average gold crystallite size is ~2-3nm.

References:

1. *J. Catal.,* **2007**, *252*, 119
2. *J. Catal.,* **2008**, *260*, 86
3. *Green Chem.,* **2008**, *10*, 168
4. *Gold Bulletin,* **2008**, *41*, 296
5. *Appl. Catal. B.,* **2013**, *132*, 195
6. *Chem. Rev.,* **2012**, *112*, 4469

79-0165 **Gold 1% on titanium dioxide extrudates (AUROlite™ Au/TiO_2)** 10g 50g
(7440-57-5)
dark purple/gray extrudates 1.5mm dia. x 5mm (avg)
(store cold)
Note: Sold in collaboration with Project AuTEK for research purposes. Reverse engineering and product modification prohibited. Only open before use, store cold in dark. See web for more details.

Analysis: Au 1 wt% ± 0.1%; TiO_2 98 wt%; Na+, Cl- <1500ppm
Bulk density: 0.85–0.95 g/ml

Technical Note:
1. Useful product for the catalytic oxidation of a variety of substrates including carbon monoxide, aldehydes, alkenes, methane and ethanol. Average gold crystallite size is ~2-3nm.

References:

1. *J.Catal.,* **2007**, *252*, 119
2. *J.Catal.,* **2008**, *260*, 86
3. *Green Chem.,* **2008**, *10*, 168
4. *Gold Bulletin,* **2008**, *41*, 296
5. *Appl. Catal. B.,* **2013**, *132*, 195
6. *Chem. Rev.,* **2012**, *112*, 4469

GOLD (Elemental Forms)

79-0170 **Gold 1% on zinc oxide granulate (AUROlite™ Au/ZnO)** *(7440-57-5)* 10g 50g
dark purple granulate 1-2mm dia.
(store cold)
Note: Sold in collaboration with Project AuTEK for research purposes. Reverse engineering and product modification prohibited. Only open before use, store cold in dark. See web for more details. PCT WO2005115612.

Analysis: Au 1 wt% ± 0.1%; ZnO 88 wt% (contains Al2O3); Na+, Cl- <1500ppm
Bulk density: 1-1.2 g/ml

Technical Note:
1. Useful product for the catalytic oxidation of a variety of substrates including carbon monoxide, aldehydes, alkenes, methane and ethanol. Average gold crystallite size is ~2-3nm.

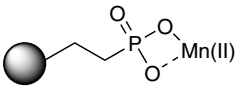
References:

1. *J.Catal.,* **2007**, *252*, 119
2. *J.Catal.,* **2008**, *260*, 86
3. *Green Chem.,* **2008**, *10*, 168
4. *Gold Bulletin,* **2008**, *41*, 296
5. *Appl. Catal. B.,* **2013**, *132*, 195
6. *Chem. Rev.,* **2012**, *112*, 4469

MANGANESE (Compounds)

25-2900 **Carulite® Catalyst** *(185036-38-8)* 250g 1kg
MnO_2/CuO; FW: 86.94/79.54; brown to black gran.; SA: 205m²/g
hygroscopic

25-1200 **Manganese(II) ethyl/butyl phosphonate Silica (PhosphonicS POMn)** 5g 25g
white solid; SA: >350 m²/g
Note: Sold in collaboration with PhosphonicS Ltd. for research purposes only. PhosphonicS Metal Oxidation Catalyst Kit component.



Particle size range: 70-200 microns
Average pore size: 60Å
Effective loadings: 0.3 to 0.5 mmol/g

25-1360 **Manganese(IV) oxide, activated** *(1313-13-9)* 50g
HAZ MnO_2; FW: 86.94; brown to black pwdr.; m.p. 535° dec.; d. 5.026 250g

96-6770 **PhosphonicS Metal Oxidation Catalyst Kit**
See page 23

MOLYBDENUM (Compounds)

27-0480 **Cobalt oxide-molybdenum oxide on alumina (3.5% CoO, 14% MoO_3)**
(1308-06-1)
See page 1

NICKEL (Elemental Forms)

28-1910 **Nickel (skeletal), molybdenum promoted (1 wt%) (supplied under water) (Actimet® 8040P)** *(7440-02-0)* 50g 250g
HAZ
black pwdr. (d50=35 µm)
Note: Sold in collaboration with BASF for research purposes only.

Technical Note:
1. Actimet® 8040P catalyst is particularly useful for the hydrogenation of nitriles and nitro groups to amines.

NICKEL (Elemental Forms)

28-1900 **Nickel, 64% powder on silica, reduced and stabilized (Ni-5249P)** 50g
HAZ *(7440-02-0)* 250g
black pwdr. (d50=5 µm); SA: 55m^2/g
Note: Sold in collaboration with BASF for research purposes only.

Technical Note:
1. Ni-5249P catalyst can be used in the slurry phase hydrogenation of nitro groups, fatty nitriles, saturated aromatics and double bonds. Also used for the hydrogenation of glucose, dextrose or sorbitol.

28-1916 **Nickel (skeletal), unpromoted (supplied under water) (Actimet® M)** 50g
HAZ *(7440-02-0)* 250g
black pwdr. (d50=35 µm)
Note: Sold in collaboration with BASF for research purposes only.

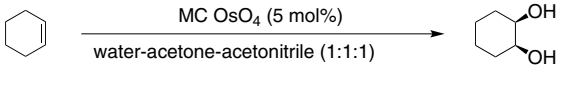
Technical Note:
1. Actimet® M catalyst is a versatile catalyst that is recommended for use in the hydrogenation of aromatics and other olefinic compounds. Also useful for the reduction of carbonyl groups and the ammonolysis of alcohols.

28-1890 **Sponge nickel catalyst (50% aqueous slurry)** *(7440-02-0)* 100g
HAZ Ni (50% slurry in water); FW: 58.71; 50% in water; SA: 80-100 m^2/g; 500g
d. 8.90 (as nickel metal)
air sensitive

OSMIUM (Compounds)

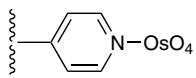
76-2956 **Osmium(VIII) oxide, Microencapsulated in a Styrene Polymer (~10%OsO_4)** 1g
HAZ
OsO_4; black solid

Technical Note:
1. Microencapsulated Osmium (VIII) oxide, in combination with a suitable co-oxidant, is a useful catalyst for the asymetric dihydroxylation of olefins to yield chiral diols. The encapsulated OsO_4 is easily separated from the reaction mixture and is reusable. Furthermore, encapsulation suppresses the volatilization of hazardous osmium tetroxide.



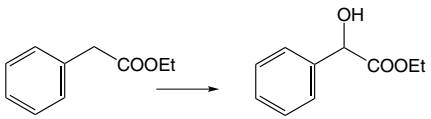
N-methylmorpoline N-oxide, rt, 12 hours

References:
1. *J. Org. Chem.,* **1998**, *63*, 6094

76-2970 **Tetraoxopyridineosmium(VIII) (~7.5% Os) polymer-bound FibreCat™** 5g


yellow, fibrous solid
Note: Limited quantities available.

Technical Note:
1. A stable polymer-bound osmium tetroxide useful for the hydroxylation of olefins. Use of this catalyst effectively eliminates the hazard of working with osmium tetroxide in the free state, while still maintaining its activity as a catalyst.



PALLADIUM (Elemental Forms)

96-6715 **BASF Blocking Group Removal Catalyst Kit**
See page 18

96-6717 **BASF Heterogeneous Catalyst Kit**
See page 19

96-6719 **BASF Palladium Catalyst Kit**
See page 19

PALLADIUM (Elemental Forms)

96-6670	**Evonik Heterogeneous Catalyst Kit** *See* page 20	
96-6672	**Evonik Heterogeneous Palladium Catalyst Kit** *See* page 21	
46-1706	**Palladium, 10% on activated carbon, Pearlman (50-70% wetted powder) Evonik Noblyst® P1070** *(7440-05-3)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Palladium Catalyst Kit component.	10g 50g
46-1890 HAZ	**Palladium, 5% on activated carbon, reduced, dry powder** *(7440-05-3)* Pd on carbon; pwdr.; SA: ~1050 m^2/g; P.Vol. 0.61 cc/g	5g 25g 100g
46-1900 HAZ	**Palladium, 10% on activated carbon, reduced, dry powder** *(7440-05-3)* Pd on carbon; pwdr.; SA: ~1000 m^2/g; P.Vol. 0.61 cc/g	2g 10g 50g
46-1907	**Palladium, 3% on activated carbon, reduced, 50% water wet paste (Escat™ 1911)** *(7440-05-3)* black pwdr. (d50=38 µm); SA: 1500m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Blocking Group Removal Catalyst Kit component.	10g 50g
46-1908	**Palladium, 5% on activated carbon, reduced, 50% water wet paste (Escat™ 1941)** *(7440-05-3)* black pwdr. (d50=38 µm); SA: 1500m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Blocking Group Removal Catalyst Kit component.	10g 50g
46-1909	**Palladium, 5% on activated carbon, reduced, 50% water wet paste (Escat™ 1961)** *(7440-05-3)* black pwdr. (d50=20 µm); SA: 850m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Blocking Group Removal Catalyst Kit component.	10g 50g
46-1911	**Palladium, 5% on activated carbon, reduced, 50% water wet paste (Escat™ 1971)** *(7440-05-3)* black pwdr. (d50=27 µm); SA: 900m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Blocking Group Removal Catalyst Kit component.	10g 50g
46-1707	**Palladium, 20% on activated carbon (Pearlman's catalyst), unreduced, 50% water wet paste (Escat™ 1951)** *(7440-05-3)* black pwdr. (d50=24 µm); SA: 850m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component. BASF Palladium Catalyst Kit component.	5g 25g

Technical Note:

1. Escat™ 1951 catalyst is recommended for a broad range of reactions common to palladium on carbon catalysts. Specifically, it is well suited for removal of protecting groups such as benzyl, FMOC and others.

46-1710	**Palladium, 0.6% on activated carbon, 50% water-wet paste (NanoSelect LF 100)** *(7440-05-3)* black solid (d50=25 µm) Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component. BASF Palladium Catalyst Kit component.	5g 25g

Technical Note:

1. NanoSelect LF 100 is a lead-free, water-wet, catalyst containing metal crystallites sizes of around 7 nm, and a mean particle size of 25 microns. The metal crystallites are supported on a carbon powder. The presence of nanometer-sized metal particles greatly increases the metal surface area available per gram of catalyst, and boosts catalytic activity. The catalyst is recommended for use in hydrogenation reactions leading to the partial reduction of functional groups. It is specifically suited for the selective hydrogenation of alkynes to alkenes, with a high selectivity for cis-alkenes.

PALLADIUM (Elemental Forms)

46-1703	**Palladium, 5% on activated carbon (50-70% wetted powder)** **Evonik Noblyst® P1086** *(7440-05-3)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Palladium Catalyst Kit component.	10g 50g
46-1740	**Palladium, 5% on activated carbon (50-70% wetted powder)** **Evonik Noblyst® P1090** *(7440-05-3)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Palladium Catalyst Kit component.	10g 50g
46-1747	**Palladium, 5% on activated carbon (50-70% wetted powder)** **Evonik Noblyst® P1092** *(7440-05-3)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Palladium Catalyst Kit component.	10g 50g
46-1743	**Palladium, 5% on activated carbon (50-70% wetted powder)** **Evonik Noblyst® P1093** *(7440-05-3)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Palladium Catalyst Kit component.	10g 50g
46-1750	**Palladium, 5% on activated carbon (50-70% wetted powder)** **Evonik Noblyst® P1109** *(7440-05-3)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Palladium Catalyst Kit component.	10g 50g
46-1901	**Palladium, 5% on activated peat carbon, reduced, 50% water wet paste (Escat™ 1621)** *(7440-05-3)* black pwdr. (d50=15 µm); SA: 850m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component. BASF Palladium Catalyst Kit component.	10g 50g

Technical Note:

1. Escat™ 1621 catalyst is recommended for a broad range of reactions common to palladium on carbon catalysts, such as hydrogenolysis under hydrogen transfer conditions.

46-1902 HAZ	**Palladium, 5% on activated wood carbon, reduced, dry (Escat™ 1431)** *(7440-05-3)* black pwdr. (d50=18 µm); SA: 900m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component.	10g 50g

Technical Note:

1. Escat™ 1431 catalyst is recommended for a broad range of reactions common to palladium on carbon catalysts, where water is detrimental to the selectivity of the reaction. Active over a wide range of conditions.

46-1905	**Palladium, 10% on activated wood carbon, reduced, 50% water wet (Escat™ 1931)** *(7440-05-3)* black pwdr. (d50=38 µm); SA: 1500m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Blocking Group Removal Catalyst Kit component. BASF Heterogeneous Catalyst Kit component. BASF Palladium Catalyst Kit component.	10g 50g

Technical Note:

1. Escat™ 1931 catalyst is recommended for a broad range of reactions commonly catalyzed by palladium on carbon. Specifically, it is well suited for removal of protecting groups such as benzyl, FMOC and others.

PALLADIUM (Elemental Forms)

46-1903	**Palladium, 5% on activated wood carbon, reduced, 50% water wet paste (Escat™ 1421)** *(7440-05-3)* black pwdr. (d50=18 µm); SA: 900m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component. BASF Palladium Catalyst Kit component.	10g 50g

Technical Note:

1. Escat™ 1421 catalyst is recommended for a broad range of reactions commonly catalyzed by palladium on carbon.

46-1904	**Palladium, 5% on activated wood carbon, unreduced, 50% water wet paste (Escat™ 1471)** *(7440-05-3)* black pwdr. (d50=18 µm); SA: 900m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component. BASF Palladium Catalyst Kit component.	10g 50g

Technical Note:

1. Escat™ 1471 catalyst is recommended for a broad range of reactions common to palladium on carbon catalysts. Specifically, it is well suited for hydrogenolysis reactions using molecular hydrogen. Active over a wide range of conditions.

46-1906	**Palladium, 10% on activated wood carbon, unreduced, 50% water wet (Escat™ 1921)** *(7440-05-3)* black pwdr. (d50=38 µm); SA: 1500m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Blocking Group Removal Catalyst Kit component. BASF Palladium Catalyst Kit component.	10g 50g

Technical Note:

1. Escat™ 1921 catalyst is recommended for a broad range of reactions common to palladium on carbon catalysts. Specifically, it is well suited for removal of protecting groups such as benzyl, FMOC and others.

46-1920	**Palladium, 0.5% on alumina, reduced** *(7440-05-3)* Pd on alumina; 1/8" x 1/8" pellets; SA: ~90 m^2/g	25g 100g
46-1950	**Palladium, 5% on alumina, reduced, dry powder** *(7440-05-3)* Pd on alumina; pwdr.	5g 25g 100g
46-1951	**Palladium, 5% on alumina powder, reduced, dry (Escat™ 1241)** *(7440-05-3)* gray pwdr. (d50=70 µm); SA: 110m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component. BASF Palladium Catalyst Kit component.	5g 25g

Technical Note:

1. Escat™ 1241 catalyst is recommended for selective hydrogenation reactions such as alkyne reduction in the presence of carboxylic groups. The particle size of the catalyst is ideal for allowing fast separation from the reaction mixture.

46-1970	**Palladium, 5% on barium carbonate, reduced** *(7440-05-3)* Pd on $BaCO_3$; pwdr.; SA: high	10g 50g
46-1989	**Palladium, 5% on barium sulfate, reduced** *(7440-05-3)* gray to black pwdr.; SA: ~2.8m^2/g; P.Vol. 0.61 cc/g	10g 50g
46-1990	**Palladium, 5% on barium sulfate, unreduced** *(7440-05-3)* Pd on $BaSO_4$; brown pwdr.; SA: ~2.8m^2/g; P.Vol. 0.61 cc/g	10g 50g
46-2020	**Palladium, 5% on calcium carbonate, lead-poisoned (LINDLAR CATALYST)** *(7440-05-3)* Pd on $CaCO_3$; pwdr.; SA: 5-10 m^2/g; P.Vol. 0.38 cc/g	10g 50g
46-2010	**Palladium, 5% on calcium carbonate, unpoisoned, reduced** *(7440-05-3)* Pd on $CaCO_3$; pwdr.; SA: 5-10 m^2/g	10g 50g
46-2015	**Palladium, 5% on calcium carbonate, unpoisoned, unreduced** *(7440-05-3)* Pd on $CaCO_3$; light brown pwdr.; SA: 12m^2/g	10g 50g

PALLADIUM (Elemental Forms)

46-2022 **Palladium, 5% on calcium carbonate, unreduced, dry (Escat™ 1371)** 5g
(7440-05-3) 25g
brownish pwdr. (d50=3 µm); SA: 7m²/g
Note: Sold in collaboration with BASF for research purposes only.

Technical Note:
1. Escat™ 1371 catalyst is recommended for selective hydrogenation reactions in which other palladium catalysts can lead to over-hydrogenation. Additional dopants can be added for improved performance.

46-2085 **Palladium, 1% on polyethylenimine/SiO_2 ROYER Pd CATALYST** *(7440-05-3)* 2g
Pd on support; 20-40 mesh beads 10g
50g

46-2087 **Palladium, 1% on polyethylenimine/SiO_2 ROYER Pd CATALYST** *(7440-05-3)* 2g
Pd on support; 40-200 mesh pwdr. 10g

46-2089 **Palladium, 3% on polyethylenimine/SiO_2 ROYER Pd CATALYST** *(7440-05-3)* 2g
Pd on support; 40-200 mesh pwdr. 10g
50g

46-2090 **Palladium, 5% on silica powder, reduced, dry (Escat™ 1351)** *(7440-05-3)* 5g
gray pwdr. (d50=40 µm); SA: 400m²/g 25g
Note: Sold in collaboration with BASF for research purposes only.

Technical Note:
1. Escat™ 1351 catalyst is recommended for selective hydrogenation reactions. The silica support enables totally different catalytic reactivity compared to carbon-based catalysts.

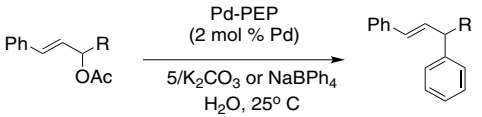
46-1711 **Palladium, 0.5% on titanium silicate, 50% water-wet paste** 5g
(NanoSelect LF 200) *(7440-05-3)* 25g
black solid (d50=25 µm)
Note: Sold in collaboration with BASF for research purposes only.

Technical Note:
1. NanoSelect LF 200 is a lead-free, water-wet, catalyst containing metal crystallites sizes of around 7 nm, and a mean particle size of 25 microns. The metal crystallites are supported on titanium silicate powder. The presence of nanometer-sized metal particles greatly increases the metal surface area available per gram of catalyst, and boosts catalytic activity. The catalyst is recommended for use in hydrogenation reactions leading to the partial reduction of functional groups. It is specifically suited for the selective hydrogenation of alkynes to alkenes, with a high selectivity for cis-alkenes.

PALLADIUM (Compounds)

46-0101 **Allylpalladium chloride dimer, supported on poly(ethylene glycol) polystyrene graft copolymer beads [~6% $(C_3H_5PdCl)_2$]** 250mg
$[C_3H_5PdCl]_2$; yellow solid
air sensitive, (store cold)

Technical Notes:
1. Resin supported Allylpalladium chloride dimer is a highly active catalyst useful in allylic substitution reactions, hydrocarbonylation of aryl halides, and cross-coupling of aryl halides and allylacetates with aryl boron reagents. The supported complex can easily be separated from the reaction mixture, and is reusable.
2. See 46-0100.



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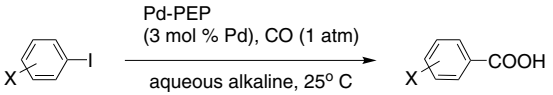

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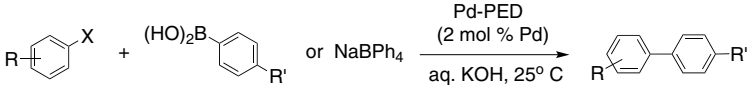
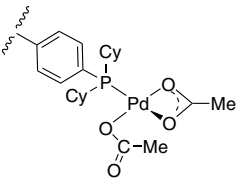


Ref. (1)

References:
1. *J. Org. Chem.,* **1999**, *64*, 3384
2. *J. Org. Chem.,* **1999**, *64*, 6921

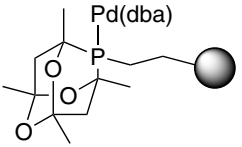
PALLADIUM (Compounds)

46-1500 **Di(acetato)dicyclohexyl-phenylphosphinepalladium (II) (~5% Pd) polymer-bound FibreCat™** — 1g, 5g
orange-brown, fibrous solid
Note: Limited quantities available.



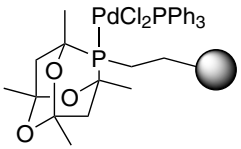
Technical Note:
1. Useful in the coupling of less active aryl chlorides with boronic acids.

46-0180 **Dibenzylideneacetonepalladium(0) 1,3,5,7-tetramethyl-2,4,6-trioxa-8-phos-phaadamantane-8- ethyl Silica (PhosphonicS PAPd2r)** — 500mg, 2g
pale green solid
Note: Sold in collaboration with PhosphonicS Ltd. for research purposes only.



Particle size range: 60-200 microns
Palladium loading: 0.01 to 0.03 mmol/g
Technical Note:
1. Immobilized palladium heterogeneous catalyst successfully utilized in typical Suzuki and Heck reactions. The catalyst is effective for a wide range of substrates yielding coupled products in high yield. The catalyst can be simply filtered off and reused over several cycles, with no apparent loss in activity. Typical reactions using the homogeneous version of dibenzylideneacetonepalladium(0) phosphaadamantane can be found in *Org. Lett.* **2003**, *5*, 6, *Tetrahedron Lett.*, **2004**, *45*, 8319 and *J.Org.Chem.*, **2004**, *69*, 5082.

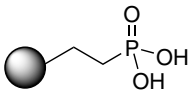
46-7860 **Triphenylphosphinepalladium(II) dichloride phosphaadamantane ethyl Silica (PhosphonicS PAPd1r)** — 500mg, 2g
yellow solid
Note: Sold in collaboration with PhosphonicS Ltd. for research purposes only.



Particle size range: 60-200 microns
Palladium loading: 0.01 to 0.03 mmol/g
Technical Note:
1. Immobilized palladium heterogeneous catalyst successfully utilized in typical Suzuki and Heck reactions. The catalyst is effective for a wide range of substrates yielding coupled products in high yield. The catalyst can be simply filtered off and reused over several cycles, with no apparent loss in activity. Typical reactions using the homogeneous version of triphenylphosphinepalladium(II) dichloride phosphaadamantane can be found in *Org. Lett.* **2003**, *5*, 6, *Tetrahedron Lett.*, **2004**, *45*, 8319 and *J.Org.Chem.*, **2004**, *69*, 5082.

PHOSPHORUS (Compounds)

15-0011 **Ethyl/butyl phosphonic acid Silica (PhosphonicS POH1)** — 10g, 50g
white solid; SA: 380 m^2/g
Note: Sold in collaboration with PhosphonicS Ltd. for research purposes only.



Particle size range: 60-200 microns
Average pore size: 60Å
Functional group loading : 0.8 to 1.0 mmol/g
Technical Note:
1. Applications include esterification, trans-esterification, hydrolysis, rearrangements, dehydration, protection and de-protection, cyclizations, etherifications. At the end of the reaction the solid silica catalyst can simply be filtered from the reaction mixture and reused.

References:
1. *Org. Process Res. Dev.*, **2007**, *11*, 406.

PLATINUM (Elemental Forms)

96-6717	**BASF Heterogeneous Catalyst Kit** *See* page 19	
96-6721	**BASF Platinum Catalyst Kit** *See* page 20	
78-1685 HAZ	**Dealloyed Pt-Co core-shell fuel cell catalyst on carbon** PtCo; black solid	100mg
78-1688 HAZ	**Dealloyed Pt-Cu core-shell fuel cell catalyst on carbon** PtCu; black solid	100mg
96-6674	**Evonik Heterogeneous Catalyst Kit for Selective Hydrogenation** *See* page 21	
78-1630	**Platinum, 0.8% on activated carbon, 50% water-wet paste (NanoSelect Pt-100)** *(7440-06-4)* Pt; black solid (d50=25µm) Note: Sold in collaboration with BASF for research purposes only.	5g 25g
78-1540	**Platinum, 3% on activated carbon, sulfided (50-70% wetted powder) Evonik Noblyst® P2065** *(7440-06-4)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Catalyst Kit for Selective Hydrogenation component.	10g 50g
78-1600 HAZ	**Platinum, 5% on activated carbon** *(7440-06-4)* Pt; pwdr.; SA: ~1023 m^2/g; b.p. 3827° (Pt); P.Vol. 0.79 cc/g; d. 21.45	10g 50g
78-1530	**Platinum, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P2058** *(7440-06-4)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Catalyst Kit for Selective Hydrogenation component.	10g 50g
78-1534	**Platinum, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P2060** *(7440-06-4)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Catalyst Kit for Selective Hydrogenation component.	10g 50g
78-1613	**Platinum, 5% on activated carbon, unreduced, 50% water wet paste (Escat™ 2441)** *(7440-06-4)* black pwdr. (d50=18 µm); SA: 900m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component. BASF Platinum Catalyst Kit component.	5g 25g

Technical Note:

1. Escat™ 2441 catalyst is recommended for a broad range of reactions common to platinum on carbon catalysts, such as nitro group reductions, reductive alkylations as well as other coupling reactions. Active over a wide range of conditions.

78-1610 HAZ	**Platinum, 10% on activated carbon** *(7440-06-4)* Pt; pwdr.; SA: ~1000 m^2/g; b.p. 3827° (Pt); P.Vol. 0.79 cc/g; d. 21.45	1g 5g 25g
78-1615	**Platinum, 5% on activated peat carbon, reduced, 50% water wet paste (Escat™ 2621)** *(7440-06-4)* black pwdr. (d50=15 µm); SA: 850m^2/g Note: Sold in collaboration with BASF for research purposes only.	5g 25g

Technical Note:

1. Escat™ 2621 catalyst is recommended for a broad range of reactions common to platinum on carbon catalysts, such as nitro group reductions, reductive alkylations as well as other coupling reactions. Active over a wide range of conditions.

PLATINUM (Elemental Forms)

78-1614 **Platinum, 3% on activated wood carbon, reduced, 70% water wet paste (Escat™ 2931)** *(7440-06-4)* — 5g, 25g
black pwdr. (d50=22 µm); SA: 1500m²/g
Note: Sold in collaboration with BASF for research purposes only. BASF Platinum Catalyst Kit component.

Technical Note:
1. Escat™ 2931 catalyst is recommended for a broad range of reactions common to platinum on carbon catalysts, such as nitro group reductions, reductive alkylations as well as other coupling reactions. Specifically recommended for the reduction of halonitroa romatics to haloanilines.

78-1612 **Platinum, 5% on activated wood carbon, reduced, 50% water wet paste (Escat™ 2421)** *(7440-06-4)* — 5g, 25g
black pwdr. (d50=18 µm); SA: 900m²/g
Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component. BASF Platinum Catalyst Kit component.

Technical Note:
1. Escat™ 2421 catalyst is recommended for a broad range of reactions common to platinum on carbon catalysts, such as nitro group reductions, reductive alkylations as well as other coupling reactions. Active over a wide range of conditions.

78-1611 HAZ **Platinum, 5% on activated wood carbon, reduced, dry (Escat™ 2431)** *(7440-06-4)* — 5g, 25g
black pwdr. (d50=18 µm); SA: 900m²/g
Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component. BASF Platinum Catalyst Kit component.

Technical Note:
1. Escat™ 2431 catalyst is recommended for a broad range of reactions common to platinum on carbon catalysts, where water is detrimental to the selectivity of the reaction. Active over a wide range of conditions.

78-1640 **Platinum, 0.5% on alumina** *(7440-06-4)* — 25g, 100g
Pt; 1/8'' x 1/8'' pellets; SA: ~100 m²/g; m.p. 1769° (Pt); b.p. 3827° (Pt); P.Vol. 0.40 cc/g; d. 21.45

78-1660 **Platinum, 5% on alumina** *(7440-06-4)* — 10g, 50g
Pt; pwdr.; SA: 80-100 m²/g; m.p. 1769° (Pt); b.p. 3827° (Pt); P.Vol. 0.41 cc/g; d. 21.45

78-1661 **Platinum, 5% on alumina powder, reduced, dry (Escat™ 2941)** *(7440-06-4)* — 5g, 25g
gray pwdr. (d50=70 µm); SA: 110m²/g
Note: Sold in collaboration with BASF for research purposes only. BASF Platinum Catalyst Kit component.

Technical Note:
1. Escat™ 2941 catalyst is recommended for selective hydrogenation reactions. The particle size of the catalyst is ideal for allowing fast separation from the reaction mixture.

78-1665 **Platinum, 5% on calcium carbonate, unreduced, dry (Escat™ 2371)** *(7440-06-4)* — 5g, 25g
black pwdr. (d50=3 µm); SA: 7m²/g
Note: Sold in collaboration with BASF for research purposes only.

Technical Note:
1. Escat™ 2371 catalyst is recommended for selective hydrogenation reactions in which other platinum catalysts can lead to over-hydrogenation. Additional dopants can be added for improved performance.

78-1635 **Platinum 0.8% and molybdenum 0.3wt% on activated carbon, 50% water-wet paste (Nanoselect Pt-200)** *(7440-06-4)* — 5g, 25g
Pt; black solid (d50=25µm)
Note: Sold in collaboration with BASF for research purposes only.

78-1675 **Platinum, 5% on silica powder, reduced, dry (Escat™ 2351)** *(7440-06-4)* — 5g, 25g
gray pwdr. (d50=40 µm); SA: 400m²/g
Note: Sold in collaboration with BASF for research purposes only.

Technical Note:
1. Escat™ 2351 catalyst is recommended for selective hydrogenation reactions common to platinum catalysts. The silica support enables totally different catalytic reactivity compared to carbon-based catalysts.

PLATINUM (Elemental Forms)

78-1536	**Platinum 1% and vanadium 2%, on activated carbon (50-70% wetted powder) Evonik Noblyst® P8078** *(7440-06-4)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Catalyst Kit for Selective Hydrogenation component.	10g 50g

PLATINUM (Compounds)

78-1892 HAZ	**Platinum(IV) oxide hydrate (~80-82% Pt) (99.95+%-Pt) ADAMS' CATALYST [BASF C7018]** *(52785-06-5)* $PtO_2 \cdot XH_2O$; FW: 227.09; brown pwdr. Note: Sold in collaboration with BASF for research purposes only. BASF Platinum Catalyst Kit component.	250mg 1g 5g
78-1890 HAZ	**Platinum(IV) oxide hydrate (~80-81% Pt) ADAMS' CATALYST** *(52785-06-5)* $PtO_2 \cdot XH_2O$; FW: 227.09; brown pwdr.; SA: high	250mg 1g 5g

RHENIUM (Elemental Forms)

75-1890 HAZ	**Rhenium powder (99.99%) PURATREM** *(7440-15-5)* Re; FW: 186.20; -325 mesh pwdr.; SA: high; m.p. 3180°; b.p. 5900°; d. 21.04	1g 5g

RHODIUM (Elemental Forms)

45-1863	**Rhodium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P3053** *(7440-16-6)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Catalyst Kit for Selective Hydrogenation component.	10g 50g
45-1875	**Rhodium, 5% on activated wood carbon, reduced, 50% water wet paste (Escat™ 3401)** *(7440-16-6)* black pwdr. (d50=18 µm); SA: 900m^2/g Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component.	1g 5g

Technical Note:

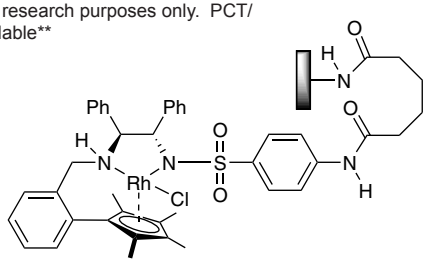
1. Escat™ 3401 catalyst is recommended for a broad range of reactions common to rhodium on carbon catalysts. Specifically, it is well suited for hydrogenation of aromatic rings at mild pressure and temperature.

45-1810	**Rhodium, 0.5% on alumina** *(7440-16-6)* Rh on Al_2O_3; 1/8'' x 1/8'' pellets; SA: ~100 m^2/g; P.Vol. 0.40 cc/g	5g 25g
45-1830	**Rhodium, 5% on alumina** *(7440-16-6)* Rh on Al_2O_3; pwdr.; SA: 80-100 m^2/g	1g 5g 25g
45-1860 HAZ	**Rhodium, 5% on carbon** *(7440-16-6)* Rh on carbon; pwdr.; SA: ~1050 m^2/g	1g 5g 25g

RHODIUM (Compounds)

45-0385 **Chloro[2-methyl{1S,2S-diphenyl-2-[(4-amidophenylsulfonyl) amido]ethyl}amino}phenyl]-2,3,4,5-tetramethylcyclopentadienyl] rhodium(III) Heterogenized Rh(III)-catalyst on a polyethylene sinter plate** 100mg 500mg

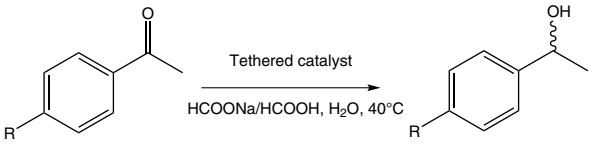
yellow-orange plate (1cm x 1cm x 1.5mm)
Note: Sold under license from PolyAn for research purposes only. PCT/EP2010/060270 **Limited quantities available**



Rhodium content: 0.05 mass%
Support material: Polyethylene
Weight of one plate: 100mg
Mean Particle Size: 30 microns

Technical Notes:

1. Catalytic generation of enantioenriched compounds.
2. Simple catalyst separation and recycling
   - continuously operated reactions possible.
3. Water as a solvent.
4. Formate as hydrogen donor - non-toxic, safe, easy to handle.
5. Irreversible hydrogen transfer (essentially no reverse reaction through the generation of CO_2).



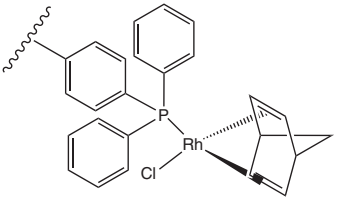
R = H, Cl, NO_2, OMe

References:

1. *Org. Lett*., **2005**, *7*, 5489.
2. *Advanced Synthesis & Catalysis*, **2010**, *352(14-15),* 2497.
3. *Synfacts*, **2010**, *1*, 112.
4. *Advanced Synthesis & Catalysis,* **2011**, *353*, 8, 1335

45-1700 **Chloronorbornadienetriphenyl-phosphinerhodium(I) (~5% Rh) polymer-bound FibreCat™** 5g

yellow, fibrous solid
air sensitive
Note: Limited quantities available.



Technical Note:

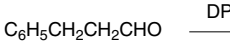
1. Versatile polymer-bound catalyst used for the selective hydrogenation of polyolefins. The supported rhodium catalyst exhibits similar selectivity to its homogeneous counterpart. In most cases, rhodium leaching is negligible.

RHODIUM (Compounds)

45-0670 **Polymer-bound chlorotris(triphenylphosphine)rhodium(I) on styrene-divinylbenzene copolymer (20% cross-linked)** *(14694-95-2)* 1g 5g
maroon beads; 20-60 mesh
air sensitive

Technical Notes:

1. A homogeneous hydrogenation catalyst which operates under mild conditions.
2. Catalyst for the decarbonylation of aldehydes.
3. Catalyst for regio- and stereoselective allylic substitution reactions.
4. Alkyne hydro-phosphorylation
5. Heck-type reaction with α,β-unsaturated esters.
6. Alkyne arylation
7. Allylic alcohol-olefin coupling.



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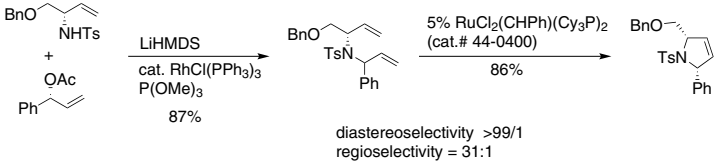

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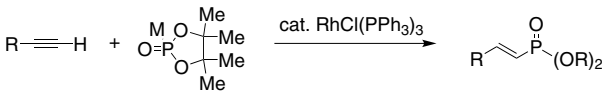
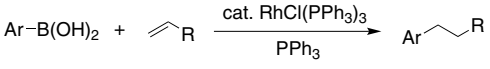


Tech. Note (4)
Ref. (5)



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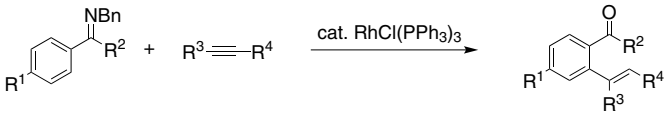

Tech. Note (6)
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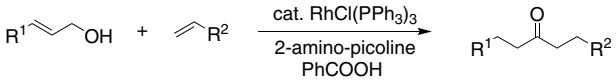


Tech. Note (7)
Ref. (8)

References:

1. *Progress Inorg. Chem.,* **1984**, *28*
2. *J. Org. Chem.,* **1992**, *57*, 5075
3. *Encyclopedia of Reagents for Organic Synthesis,* **1995**, *Vol*, 2, 1253
4. *Org. Lett.,* **1999**, *1*, 1929
5. *Angew. Chem. Int. Ed.,* **2001**, *40*, 1929
6. *Chem. Commun.,* **2003**, *2438*
7. *Org. Lett.,* **2003**, *5*, 2759
8. *J. Org. Chem.,* **2002**, *67*, 3945

RUTHENIUM (Elemental Forms)

44-4065	**Ruthenium, 5% on activated carbon, reduced, 50% water wet paste (Escat™ 4401)** *(7440-18-8)* black pwdr. (d50=18 µm); SA: 900m²/g Note: Sold in collaboration with BASF for research purposes only. BASF Heterogeneous Catalyst Kit component.	5g 25g

Technical Note:

1. Escat™ 4401 catalyst is recommended for a broad range of reactions common to ruthenium on carbon catalysts. Specifically, it is well suited for carbonyl hydrogenation, such as sugars.

44-4060	**Ruthenium, 5% on activated carbon, (50-70% wetted powder) Evonik Noblyst® P3060** *(7440-18-8)* wetted, black pwdr. Note: Sold in collaboration with Evonik for research purposes only. Evonik Heterogeneous Catalyst Kit component. Evonik Heterogeneous Catalyst Kit for Selective Hydrogenation component.	10g 50g
44-3880	**Ruthenium, 0.5% on alumina** *(7440-18-8)* Ru on alumina; 1/8" x 1/8" pellets; SA: ~100 m²/g	25g 100g
44-3910	**Ruthenium, 5% on alumina** *(7440-18-8)* Ru on alumina; pwdr.; SA: 80-100 m²/g; P.Vol. 0.40 cc/g	25g 100g
44-4000 HAZ	**Ruthenium, 0.5% on carbon** *(7440-18-8)* Ru on carbon; 4-12 mesh gran.; SA: ~1000 m²/g	25g 100g
44-4050 HAZ	**Ruthenium, 5% on carbon** *(7440-18-8)* Ru on carbon; pwdr.	5g 25g 100g

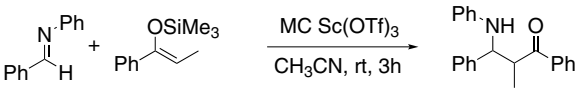
SCANDIUM (Compounds)

21-2004	**Scandium(III) trifluoromethanesulfonate (Scandium triflate), Micro-encapsulated in a Styrene Polymer [~13% $Sc(SO_3CF_3)_3$]** $Sc(SO_3CF_3)_3$; white solid	500mg

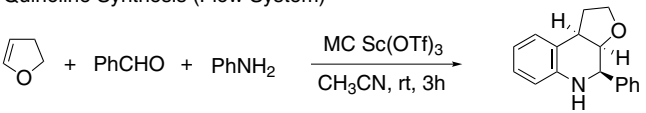
Technical Note:

1. Microencapsulated Scandium triflate is a useful Lewis acid catalyst which can be applied to various synthetic procedures such as the aldol, Michael, alkylation, Friedel-Crafts acylation, Mannich and Strecher type reactions. The encapsulated $Sc(SO_3CF_3)_3$ has a higher activity than the free monomer, can easily be separated from the reaction mixture, and is reusable.

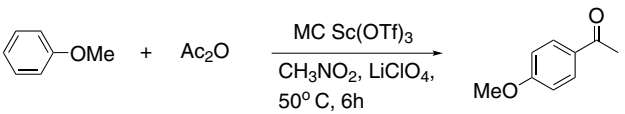
Imino Aldol Reaction (Flow System)



Quinoline Synthesis (Flow System)



Friedel-Crafts Acylation (Batch System)



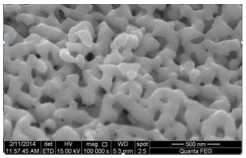
References:

1. *J. Am. Chem. Soc.,* **1998**, *120*, 2985
2. *Eur. J. Org. Chem.,* **1999**, *15*

SILVER (Elemental Forms)

47-0645 NEW HAZ

Silver Nano-Porous Catalyst (promoted with zirconium oxide)
Ag; grey pwdr.
Note: Sold under license from OXENERGY for research purposes only.
US Patent No 8,142,938.



1g
5g
25g

Specifications:
*Average cluster (particle) size, micron:*12-17; *Average cluster porosity, %:*38-42; *Average pore size, nm:* 30-50; *Specific surface area, m^2/g:/ 6.0-7.0; Apparent density, g/ml:* 0.9-1.1

47-2500 **Silver on alumina** *(7440-22-4)* 100g
Ag on Al_2O_3; FW: 107.87; 2-4mm spheres 500g

SODIUM (Compounds)

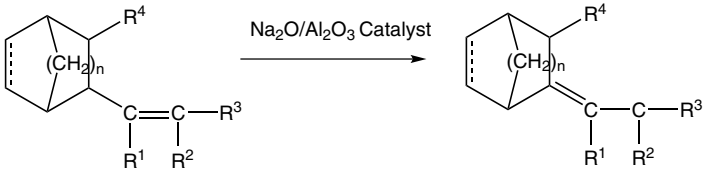
11-1007 HAZ

Sodium oxide/sodium on alumina, Olefin Isomerization Catalyst (Na_2O 11.5-13.5%, Na 1.8-3.0%)
Na_2O/Na; white solid
moisture sensitive

10g
50g

Catalyst benefits:
·Very active and highly selective olefin isomerization catalyst
·Highly resistant to catalyst poisons (tetrahydroindene, cyclopentadiene, etc.)

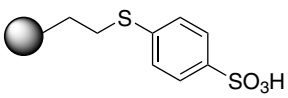
Uses:
·Diene monomer in the production of EPDM rubber.
·Scent carrier for flavors and fragrances.



SULFUR (Compounds)

16-0760

Phenyl sulfonic acid ethyl sulfide Silica (PhosphonicS SPhSA)
white to cream solid; SA: 380 m^2/g
Note: Sold in collaboration with PhosphonicS Ltd. for research purposes only. Also see 15-0011.



10g
50g

Particle size range: 315-700 microns
Average pore size: 60Å
Functional group loading: 0.5 to 0.8 mmol/g
Technical Note:

1. Applications include esterification, trans-esterification, hydrolysis, rearrangements, dehydration, protection and de-protection, cyclizations, etherifications. At the end of the reaction the solid silica catalyst can simply be filtered from the reaction mixture and reused.

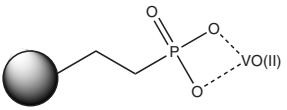
References:

1. *Manufacturing Chemist,* **2007**, *July/August Ed. 27*

VANADIUM (Compounds)

96-6770 **PhosphonicS Metal Oxidation Catalyst Kit**
See page 23

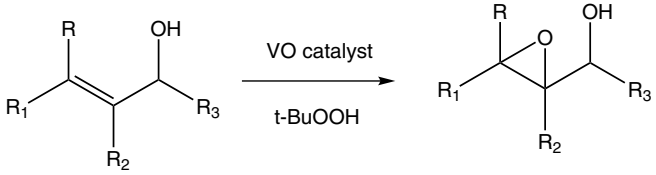
23-4380 **Vanadyl(II) ethyl/butyl phosphonate Silica (PhosphonicS POVO)** 5g 25g



blue-green solid; SA: >350 m^2/g
Note: Sold in collaboration with PhosphonicS Ltd. for research purposes only. PhosphonicS Metal Oxidation Catalyst Kit component.

Particle size range: 70-200 microns
Average pore size: 60Å
Effective loadings: 0.3 to 0.5 mmol/g
Technical Note:

1. Catalyst used for oxidation of a wide variety allylic alcohols.



References:

1. *Tetrahedron Lett.,* **2004**, *45*, 4465

ZINC (Compounds)

30-2700 **Zinc oxide, catalyst (85-95% ZnO, 3-7% Al_2O_3, 0.5-3% CaO)** 100g 500g
(1314-13-2)
ZnO; FW: 81.37; 3/16'' extrusions; SA: ~35 m^2/g

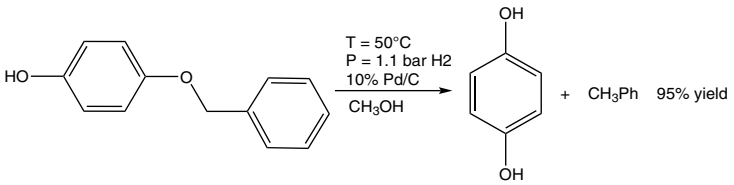
HETEROGENEOUS KITS - BASF Blocking Group Removal Catalyst Kit

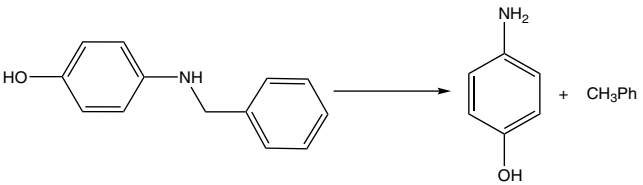
96-6715 **BASF Blocking Group Removal Catalyst Kit**
Sold in collaboration with BASF for research purposes only.
Components also available for individual sale.
Contains the following:

46-1905	Palladium, 10% on activated wood carbon, reduced, 50% water wet (Escat™ 1931) *(7440-05-3)*	10g	See page 6
46-1906	Palladium, 10% on activated wood carbon, unreduced, 50% water wet (Escat™ 1921) *(7440-05-3)*	10g	See page 7
46-1907	Palladium, 3% on activated carbon, reduced, 50% water wet paste (Escat™ 1911) *(7440-05-3)*	10g	See page 5
46-1908	Palladium, 5% on activated carbon, reduced, 50% water wet paste (Escat™ 1941) *(7440-05-3)*	10g	See page 5
46-1909	Palladium, 5% on activated carbon, reduced, 50% water wet paste (Escat™ 1961) *(7440-05-3)*	10g	See page 5
46-1911	Palladium, 5% on activated carbon, reduced, 50% water wet paste (Escat™ 1971) *(7440-05-3)*	10g	See page 5

Technical Note:

1. In synthesis, the commonly practiced deprotection of benzylated alcohols and amines by precious metal catalyzed hydrogenolysis requires that the catalyst achieve complete deprotection under a limited range of available process conditions and in the presence of various process solvents and complex organic functionalities. Relative to classic catalysts, the Englehard family of blocking group removal catalysts exhibits unprecedented high intrinsic catalytic activity, exceptional fast filtration characteristics, robust functional group tolerance, and good activity in a broad range of solvents.





HETEROGENEOUS KITS - BASF Heterogeneous Catalyst Kit

96-6717 **BASF Heterogeneous Catalyst Kit**
HAZ Product offered is commercial grade, sold in collaboration with BASF for research purposes only.
Components also available for individual sale. Contains the following:

44-4065	Ruthenium, 5% on activated carbon, reduced, 50% water wet paste (Escat™ 4401) *(7440-18-8)*	5g	See page 15
45-1875	Rhodium, 5% on activated wood carbon, reduced, 50% water wet paste (Escat™ 3401) *(7440-16-6)*	1g	See page 12
46-1707	Palladium, 20% on activated carbon (Pearlman's catalyst), unreduced, 50% water wet paste (Escat™ 1951) *(7440-05-3)*	5g	See page 5
46-1710	Palladium, 0.6% on activated carbon, 50% water-wet paste (NanoSelect LF 100) *(7440-05-3)*	5g	See page 5
46-1901	Palladium, 5% on activated peat carbon, reduced, 50% water wet paste (Escat™ 1621) *(7440-05-3)*	10g	See page 6
46-1902	Palladium, 5% on activated wood carbon, reduced, dry (Escat™ 1431) *(7440-05-3)*	10g	See page 6
46-1903	Palladium, 5% on activated wood carbon, reduced, 50% water wet paste (Escat™ 1421) *(7440-05-3)*	10g	See page 7
46-1904	Palladium, 5% on activated wood carbon, unreduced, 50% water wet paste (Escat™ 1471) *(7440-05-3)*	10g	See page 7
46-1905	Palladium, 10% on activated wood carbon, reduced, 50% water wet (Escat™ 1931) *(7440-05-3)*	10g	See page 6
46-1951	Palladium, 5% on alumina powder, reduced, dry (Escat™ 1241) *(7440-05-3)*	5g	See page 7
78-1611	Platinum, 5% on activated wood carbon, reduced, dry (Escat™ 2431) *(7440-06-4)*	5g	See page 11
78-1612	Platinum, 5% on activated wood carbon, reduced, 50% water wet paste (Escat™ 2421) *(7440-06-4)*	5g	See page 11
78-1613	Platinum, 5% on activated carbon, unreduced, 50% water wet paste (Escat™ 2441) *(7440-06-4)*	5g	See page 10

HETEROGENEOUS KITS - BASF Palladium Catalyst Kit

96-6719 **BASF Palladium Catalyst Kit**
HAZ Product offered is commercial grade, sold in collaboration with BASF for research purposes only.
Components also available for individual sale. Contains the following:

46-1707	Palladium, 20% on activated carbon (Pearlman's catalyst), unreduced, 50% water wet paste (Escat™ 1951) *(7440-05-3)*	5g	See page 5
46-1710	Palladium, 0.6% on activated carbon, 50% water-wet paste (NanoSelect LF 100) *(7440-05-3)*	5g	See page 5
46-1901	Palladium, 5% on activated peat carbon, reduced, 50% water wet paste (Escat™ 1621) *(7440-05-3)*	10g	See page 6
46-1902	Palladium, 5% on activated wood carbon, reduced, dry (Escat™ 1431) *(7440-05-3)*	10g	See page 6
46-1903	Palladium, 5% on activated wood carbon, reduced, 50% water wet paste (Escat™ 1421) *(7440-05-3)*	10g	See page 7
46-1904	Palladium, 5% on activated wood carbon, unreduced, 50% water wet paste (Escat™ 1471) *(7440-05-3)*	10g	See page 7
46-1905	Palladium, 10% on activated wood carbon, reduced, 50% water wet (Escat™ 1931) *(7440-05-3)*	10g	See page 6
46-1906	Palladium, 10% on activated wood carbon, unreduced, 50% water wet (Escat™ 1921) *(7440-05-3)*	10g	See page 7
46-1951	Palladium, 5% on alumina powder, reduced, dry (Escat™ 1241) *(7440-05-3)*	5g	See page 7

HETEROGENEOUS KITS - BASF Platinum Catalyst Kit

96-6721 HAZ	**BASF Platinum Catalyst Kit** Product offered is commercial grade, sold in collaboration with BASF for research purposes only. Components also available for individual sale. Contains the following:		
78-1611	Platinum, 5% on activated wood carbon, reduced, dry (Escat™ 2431) *(7440-06-4)*	5g	See page 11
78-1612	Platinum, 5% on activated wood carbon, reduced, 50% water wet paste (Escat™ 2421) *(7440-06-4)*	5g	See page 11
78-1613	Platinum, 5% on activated carbon, unreduced, 50% water wet paste (Escat™ 2441) *(7440-06-4)*	5g	See page 10
78-1614	Platinum, 3% on activated wood carbon, reduced, 70% water wet paste (Escat™ 2931) *(7440-06-4)*	5g	See page 11
78-1661	Platinum, 5% on alumina powder, reduced, dry (Escat™ 2941) *(7440-06-4)*	5g	See page 11
78-1892	Platinum(IV) oxide hydrate (~80-82% Pt) (99.95+%-Pt) ADAMS' CATALYST [BASF C7018] *(52785-06-5)*	1g	See page 12

HETEROGENEOUS KITS - Evonik Heterogeneous Catalyst Kit

96-6670	**Evonik Heterogeneous Catalyst Kit** Sold in collaboration with Evonik for research purposes only. Components also available for individual sale. Contains the following:		
44-4060	Ruthenium, 5% on activated carbon, (50-70% wetted powder) Evonik Noblyst® P3060 *(7440-18-8)*	10g	See page 15
45-1863	Rhodium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P3053 *(7440-16-6)*	10g	See page 12
46-1703	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1086 *(7440-05-3)*	10g	See page 6
46-1706	Palladium, 10% on activated carbon, Pearlman (50-70% wetted powder) Evonik Noblyst® P1070 *(7440-05-3)*	10g	See page 5
46-1740	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1090 *(7440-05-3)*	10g	See page 6
46-1743	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1093 *(7440-05-3)*	10g	See page 6
46-1747	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1092 *(7440-05-3)*	10g	See page 6
46-1750	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1109 *(7440-05-3)*	10g	See page 6
78-1530	Platinum, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P2058 *(7440-06-4)*	10g	See page 10
78-1534	Platinum, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P2060 *(7440-06-4)*	10g	See page 10
78-1536	Platinum 1% and vanadium 2%, on activated carbon (50-70% wetted powder) Evonik Noblyst® P8078 *(7440-06-4)*	10g	See page 12
78-1540	Platinum, 3% on activated carbon, sulfided (50-70% wetted powder) Evonik Noblyst® P2065 *(7440-06-4)*	10g	See page 10

HETEROGENEOUS KITS - Evonik Heterogeneous Catalyst Kit for Selective Hydrogenation

96-6674	**Evonik Heterogeneous Catalyst Kit for Selective Hydrogenation** Sold in collaboration with Evonik for research purposes only. Components also available for individual sale. Contains the following:		
44-4060	Ruthenium, 5% on activated carbon, (50-70% wetted powder) Evonik Noblyst® P3060 *(7440-18-8)*	10g	See page 15
45-1863	Rhodium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P3053 *(7440-16-6)*	10g	See page 12
78-1530	Platinum, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P2058 *(7440-06-4)*	10g	See page 10
78-1534	Platinum, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P2060 *(7440-06-4)*	10g	See page 10
78-1536	Platinum 1% and vanadium 2%, on activated carbon (50-70% wetted powder) Evonik Noblyst® P8078 *(7440-06-4)*	10g	See page 12
78-1540	Platinum, 3% on activated carbon, sulfided (50-70% wetted powder) Evonik Noblyst® P2065 *(7440-06-4)*	10g	See page 10

HETEROGENEOUS KITS - Evonik Heterogeneous Palladium Catalyst Kit

96-6672	**Evonik Heterogeneous Palladium Catalyst Kit** Sold in collaboration with Evonik for research purposes only. Components also available for individual sale. Contains the following:		
46-1703	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1086 *(7440-05-3)*	10g	See page 6
46-1706	Palladium, 10% on activated carbon, Pearlman (50-70% wetted powder) Evonik Noblyst® P1070 *(7440-05-3)*	10g	See page 5
46-1740	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1090 *(7440-05-3)*	10g	See page 6
46-1743	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1093 *(7440-05-3)*	10g	See page 6
46-1747	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1092 *(7440-05-3)*	10g	See page 6
46-1750	Palladium, 5% on activated carbon (50-70% wetted powder) Evonik Noblyst® P1109 *(7440-05-3)*	10g	See page 6

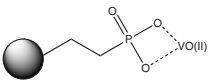
	96-6670 - Heterogeneous Catalyst Kit											
	96-6672 - Palladium Catalyst Kit						96-6674 - Selective Hydrogenation Kit					
Strem Item #	**46-1706**	**46-1703**	**46-1740**	**46-1747**	**46-1743**	**46-1750**	**78-1530**	**78-1534**	**78-1540**	**45-1863**	**44-4060**	**78-1536**
Evonik Item #	E 101 NE/W	E 101 R/W	E 105 N/W	E 105 NN/W	E 105 O/W	E 107 MA/	F 1015 RE/W	F 105 N/W	F 1082 QHA/W	G 106 N/W	H 198 P/W	CF 1082 BV/W
Nobylst® nomenclature Application/ Catalyst	Nobylst® P 1070 10% Pd	Nobylst® P 1086 5% Pd	Nobylst® P 1090 5% Pd	Nobylst® P 1092 5% Pd	Nobylst® P 1093 5% Pd	Nobylst® P 1109 5% Pd	Nobylst® P 2058 5% Pt	Nobylst® P 2060 5% Pt	Nobylst® P 2065 3% Pt	Nobylst® P 3053 5% Rh	Nobylst® P 3060 5% Ru	Nobylst® P 8078 1% Pt
Hydrogenation of C=C Double Bonds		●		○	●	○						
Hydrogenation of CN Bonds	○		○	●		●	○	●		●		
Reduction of the C=O Group		○		●	○	●				●	●	
Hydrogenation of Nitro Groups	●	●		●	○	○	●	○	○			●
Hydrogenolysis Reactions (Deprotections, Dehalogenations, etc.)	○		●	●		○						
Reductive Alkylation and Amination		●	○	○	●				●			
Hydrogenation of (Hetero) Aromatic Rings		●	○	●	○		○	○		●	●	
Oxidations (Alcohols and Sugars)							●	●				
CC Coupling Reactions	○			●	●	○						
											○ recommended ● preferred	

Note: Please refer to the different reaction classes in the Evonik manual for more detailed information regarding selectivity, activity and reaction conditions. This sample kit is deisgned as an entry point to find a suitable catalyst. Please contact one of our technical specialists for further recommendations. Most often the catalyst performance can be improved significantly by tailoring the catalyst to your requirements.

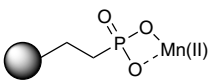
The recommendations given above are believed to be accurate at the time of publication but EVONIK makes no warranty with respect therto, including but not limited to any results to be obtained or the infrigement of any proprietary right.

HETEROGENEOUS KITS - PhosphonicS Metal Oxidation Catalyst Kit

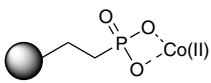
96-6770 **PhosphonicS Metal Oxidation Catalyst Kit**
Sold in collaboration with PhosphonicS Ltd. for research purposes only.
Components also available for individual sale.
Contains the following:



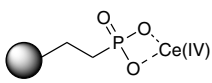
23-4380 5g



25-1200 5g



27-0900 5g



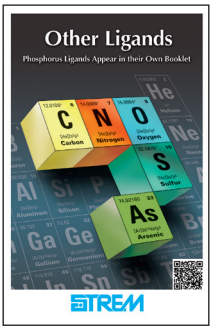
58-5100 5g

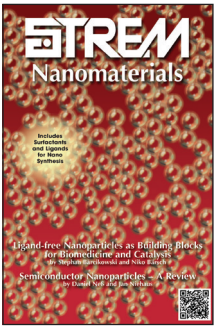
23-4380	Vanadyl(II) ethyl/butyl phosphonate Silica (PhosphonicS POVO)	5g	See page 17
25-1200	Manganese(II) ethyl/butyl phosphonate Silica (PhosphonicS POMn)	5g	See page 3
27-0900	Cobalt(II) ethyl/butyl phosphonate Silica (PhosphonicS POCo)	5g	See page 1
58-5100	Cerium(IV) ethyl/butyl phosphonate Silica (PhosphonicS POCe)	5g	See page 1

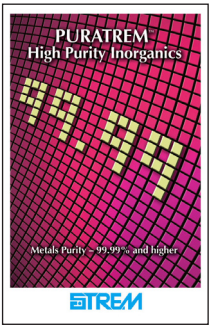
Technical Note:

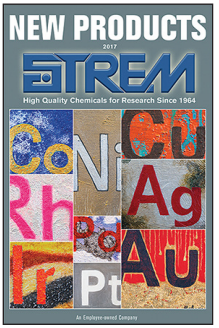
Reactions such as allylic and benzylic oxidations, alcohol oxidations and epoxidations are key chemical transformations in organic synthesis. In general these reactions are conducted by the use of stoichiometric, or even higher concentrations, of inorganic oxidants. Typical oxidizing agents include potassium permanganate, manganese dioxide, chromium trioxide, potassium chromate, potassium dichromate and peracids. These hazardous reagents produce large volumes of toxic wastes that are becoming increasingly costly to treat and dispose. In addition, difficulties are often encountered in the work up of reactions and purification of the products. There is a need for new heterogeneous oxidation catalysts that are not only effective, but exhibit ease of recovery and recycleability. PhosphonicS has developed a number of novel heterogeneous oxidation catalysts for a wide range of applications in the pharmaceutical, fine chemicals and petrochemical industries. Reactions include allylic and benzylic oxidations, epoxidations and the selective oxidations of alcohols to ketones and sulfides to sulfoxides.

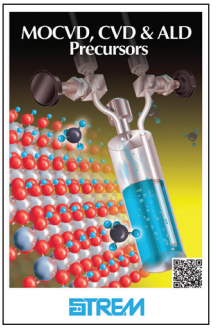
Available Booklets

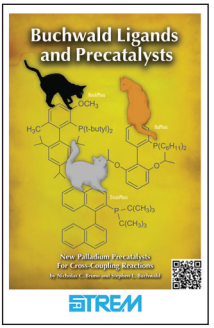


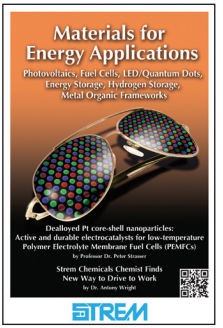












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