Ultra Pure Inorganics for:

Catalysis

Crystal Growth Technology

Photovoltaic Materials

Optical Fibers

Lasers

Acros Organics Ultra Pure Inorganics

Application Overview

ACROS ORGANICS

Introduction

High purity inorganics with ultra low metal contaminants have many important applications in today's high technologies, ranging from optical fibers to solar panels. Acros Organics offer a line of ultra pure inorganics with trace metal content less than 100 ppm to as low as 1 ppm. In order to meet the increasing market demand, we have recently expanded our ultra purity inorganics offering by 50%. In this brochure, you will find the overview of the five most important applications of our ultra high purity inorganics.

- **Catalysis**
- **Crystal Growth Technology**
- **Photovoltaic Materials**
- **Optical fibers**
- **Lasers**

Catalysis

The use of high purity inorganics as catalysts, catalyst precursors or reagents in organic synthesis offers the chance to reduce or remove unwanted impurities from a synthetic sequence.

This in turn can reduce purification requirements and waste generated from a reaction. Catalysis reactions are ubiquitous in our modern world, from increasing the efficiency of petroleum refining, cleaning car exhaust emissions with catalytic converters, producing cleaner, safer and more effective drugs or making the plastic cups from which we drink. All of these processes depend on catalysts.

Desired Catalysis requirements include:

- High Activity – allows for minimal catalyst volume while generating short reaction times.
- High Selectivity – produces desired products at high yield and eliminates unwanted by-products.
- Long Life – resistant to poisoning of the active catalytic site/state.
- Recycle/Removal Capability – ability to easily remove catalyst from a reaction and/or reuse.

By tailoring your reaction by selecting the right catalyst for the desired reaction outcome, one can achieve these four criteria.

Typical Acros Organics products used in catalysis:

Example products:		
Product ID	**Compound**	**% Purity**
19369	Palladium powder, particle size-20 mesh	99.99
19368	Palladium (II) Oxide	99.999
19371	Platinum Powder	99.999
43720	Hydrogen Hexachloroplatinate(IV) hydrate	99.999
43717	Hydrogen terachlroaurate hydrate	99.999
43709	Rhodium (III) chloride	99.99

Crystal Growth Technology

Since flame-fusion growth was documented in 1902 by Verneuil for the commercial production of rubies, crystal growth technology has found applications in micro-electronics, communications technology, energy and space technology and medical instrumentation. Modern techniques require the use of high grade materials to prevent flaws forming in the crystals.

Some common Crystal Growth Techniques include:

- Crucible Grown Crystals (Czochralski process)- a crystal is "pulled" out of a quartz crucible filled with melt.
- Micro-pulling-down method – based on the continuous transport of melted substance through micro-channels made in a crucible bottom.
- Flame-fusion (Verneuil) Growth- involves melting finely powdered substances and crystallizing the melted droplets.

Applications of Crystal Growth Technology are:

- Semi-Conductor crystals
- Optical Crystals
- Acousto-Optic Crystals
- Scintillator Crystals
- Lasers
- Jewelry and watches

Typical Acros Organics products used in CGT applications:

Example products:		
Product ID	**Compound**	**% Purity**
31812	Tellurium(IV) Oxide	99.9995
19356	Neodymium Oxide	99.999
19448	Yttrium Oxide	99.999

Photovoltaic Materials

Monocrystalline silicon, polycrystalline silicon, cadmium telluride (CdTe) and copper indium/gallium selenide (CIGS) materials are commonly used to develop solar energy generators.

CdTe is a thin film that can be deposited on substrates easily and is an ideal semiconductor for photovoltaic applications. Its advantages include simplified manufacturing, it absorbs sunlight efficiently,and there are abundant raw materials.

CIGS is a thin-film that can be deposited on multiple substrates and performs with the highest efficiency of all thin-films. Its advantages are the low relative cost of production, high efficiency, and flexibility of substrates available to bond.

The main benefits of solar photovoltaic electricity are:

- Virtually zero environmental impact.
- Low operating costs, once installed little maintenance cost.
- Reliable operating systems.
- Grid-connected solar electricity can be used locally thus reducing transmission/distribution losses.
- Economically superior where grid connection or fuel transportation is difficult, costly or impossible (islands, satellites, ships).

Typical Acros Organics products used in photovoltaic applications include:

Example products:

Product ID	Compound	% Purity
19319	Indium(III) Chloride	99.995
31812	Tellurium(IV) Oxide	99.9995
19307	Gallium	99.9999
19398	Selenium(IV) Oxide	99.999

Optical Fibers

High purity inorganics can be used as dopants in the glass core and cladding of optical fibers to reduce attenuation by changing the refractive index. They can also be used to amplify optical signals or lasers. The optical fibers have applications in communications, sensors, lighting and analytical industries.

A standard optical wire consists of the glass core, the cladding and the buffer coating.

The core is made with a higher index of refraction, an optical parameter that is a measure of the speed of light in the material, than the cladding, resulting in “total internal reflection”, or trapping the light in the core and thus reducing attenuation or light intensity loss. The buffer coating protects the fiber from the environment.

The main benefits of optical fibers are:

- Lower cost to manufacture than copper.
- Lower power usage needed to send signal and no need to boost signal once sent.
- Lighter and thinner allowing for more fibers to be fit into a cable.
- Higher capacity to transmit data (~1 terabit/second vs ~50 megabits for copper).
- Better signal integrity with little degradation.
- Can be used in dangerous environments where electrical signals could cause hazards (from pool lighting to flammable environments).

Applications of optical fibers:

- Communications
- Sensors
- Lighting
- Medical probes/Medical imaging
- Spectroscopy of large objects, permanent structures, gaseous environments

Typical Acros Organics products used in optical fiber applications include:

- Dopants in glass core and cladding to reduce attenuation by changing the refractive index.
- Dopants used as amplifiers of optical signal or lasers. Typically Rare Earth Metals.

Examples products:

Product ID	Compound	% Purity
19000	Germanium Dioxide	99.999
43718	Ytterbium Chloride hexahydrate	99.999
19302	Europium (III) Oxide	99.99

Lasers

Inorganic materials are used to dope the gain medium of solid state lasers. When energy is supplied to the crystal the dopant ions enable the crystal to amplify light at the laser wavelength. Common dopants include Chromium, Neodymium, Ytterbium, Holmium, Thulium, Scandium and Erbium.

Some common uses of lasers are:

- Barcode scanners, presentation pointers
- CD players, laser printers
- Welding tools, metal cutting and etching tools
- Spectroscopy, fluorescence microscopy, Raman spectroscopy
- Defense systems: target marking, guided munitions, H missile defense
- Windshear monitors at airports
- Entertainment light shows

Typical Acros Organics products used in laser technology include:

Example products:		
Product ID	**Compound**	**% Purity**
19448	Yttrium (III) Oxide	99.999
26430	Ytterbium Oxide	99.99
19396	Scandium Oxide	99.999
19356	Neodymium (III) Oxide	99.999

Selected Acros Organics Ultra Pure Inorganics

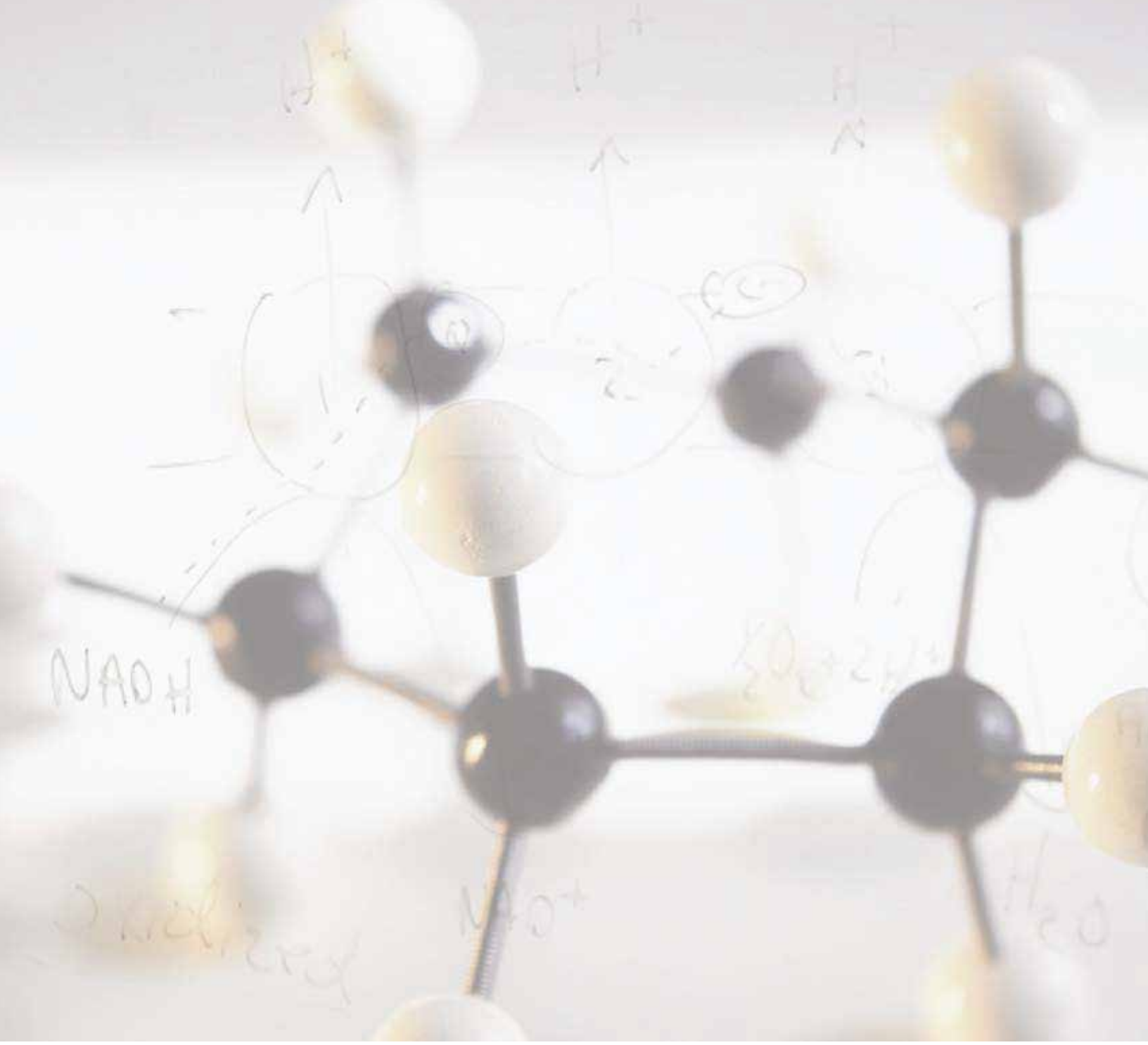
PRODUCT DESCRIPTION	PRODUCT CODE	CASNO	% PURITY
Aluminium chloride	364810200, 20 GR; 364811000, 100 GR	7446-70-0	99.999
Aluminium isopropoxide	212230100, 10 GR; 212230500, 50 GR; 212232500, 250 GR	555-31-7	99.99
Aluminium nitrate nonahydrate	212240100, 10 GR; 212241000, 100 GR	7784-27-2	99.999
Aluminium oxide	212250250, 25 GR; 212251000, 100 GR	1344-28-1	99.99
Aluminium sulfate	192430050, 5 GR; 192430250, 25 GR; 192431000, 100 GR	10043-01-3	99.999
Ammonium dihydrogen phosphate	436790250, 25 GR; 436791000, 100 GR; 436795000, 500 GR	7722-76-1	99.999
Ammonium hexabromoplatinate(IV)	193740010, 1 GR; 193740020, 2 GR; 193740100, 10 GR	17363-02-9	99.99
Ammonium hexachloroosmate(IV)	197630010, 1 GR	12125-08-5	99.99
Ammonium hexachlororuthenate(IV)	436930010, 1 GR	18746-63-9	99.99
Ammonium hexafluorosilicate	194000100, 10 GR; 194000500, 50 GR; 194002500, 250 GR	16919-19-0	99.999
Ammonium hexafluorotitanate(IV)	194350100, 10 GR; 194350500, 50 GR; 194352500, 250 GR	16962-40-6	99.99
Ammonium hydrogen difluoride	436990250, 25 GR; 436991000, 100 GR	1341-49-7	99.999
Ammonium metavanadate	194400100, 10 GR; 194400500, 50 GR	7803-55-6	99.996
Ammonium molybdate	193520050, 5 GR; 193520250, 25 GR; 193521000, 100 GR	13106-76-8	99.998
Ammonium nitrate	436960250, 25 GR; 436961000, 100 GR	6484-52-2	99.999
Ammonium orthoarsenate trihydrate	192480050, 5 GR	13477-86-6	99.999
Ammonium sulfate	194150500, 50 GR; 194152500, 250 GR	7783-20-2	99.9999
Ammonium tetrachloroplatinate(II)	193750010, 1 GR; 193750050, 5 GR	13820-41-2	99.998
Ammonium tetrathiomolybdate	389530010, 1 GR; 389530100, 10 GR; 389530500, 50 GR	15060-55-6	99.99
Barium bromide	315380050, 5 GR	10553-31-8	99.999
Barium hydroxide octahydrate	377820050, 5 GR; 377820250, 25 GR	12230-71-6	99.99
Bismuth oxychloride	212300100, 10 GR; 212300500, 50 GR; 212302500, 250 GR	7787-59-9	99.99

PRODUCT DESCRIPTION	PRODUCT CODE	CASNO	% PURITY
Bismuth(III) chloride	318350050, 5 GR; 318350250, 25 GR	7787-60-2	99.999
Bismuth(III) nitrate pentahydrate	315150050, 5 GR; 315150250, 25 GR; 315151000, 100 GR	10035-06-0	99.999
Bismuth(III) oxide	192620100, 10 GR	1304-76-3	99.9999
Boric acid	315181000, 100 GR; 315185000, 500 GR	10043-35-3	99.99
Cadmium carbonate	212320050, 5 GR	513-78-0	99.999
Cadmium chloride	296330050, 5 GR; 296330250, 25 GR	10108-64-2	99.99
Calcium carbonate	437190050, 5 GR; 437190250, 25 GR	471-34-1	99.999
Calcium hydroxide	385610050, 5 GR	1305-62-0	99.995
Cerium(III) sulfate	378660500, 50 GR; 378662500, 250 GR	13454-94-9	99.99
Cerium(III) sulfate octahydrate	192790500, 50 GR; 192792500, 250 GR	10450-59-6	99.99
Cesium carbonate	278020100, 10 GR; 278020500, 50 GR	534-17-8	99.995
Cesium chloride	192810100, 10 GR; 192810500, 50 GR; 192812500, 250 GR	7647-17-8	99.999
Cesium iodide	192820010, 1 GR; 192820100, 10 GR; 192820500, 50 GR	7789-17-5	99.999
Cesium nitrate	192070500, 50 GR; 192072500, 250 GR	7789-18-6	99.99
Chromium nitrate nonahydrate	437100050, 5 GR	7789-02-8	99.99
cis-Dichlorodiamineplatinum(II)	193762500, 250MG; 193760010, 1 GR; 193760050, 5 GR	15663-27-1	99.99
Cobalt	192850050, 5 GR; 192850250, 25 GR	7440-48-4	99.999
Cobalt(II) sulfate hydrate	379600100, 10 GR; 379600500, 50 GR	60459-08-7	99.999
Copper	437050250, 25 GR; 437051250, 125 GR	7440-50-8	99.9998
Copper(I) chloride	212420100, 10 GR; 212421000, 100 GR	7758-89-6	99.99
Copper(I) iodide	201500050, 5 GR; 201500250, 25 GR; 201501000, 100 GR	7681-65-4	99.995
Erbium chloride hydrate	192980250, 25 GR	19423-85-9	99.997
Europium(III) chloride hexahydrate	193010010, 1 GR; 193010050, 5 GR; 193010250, 25 GR	13759-92-7	99.99
Europium(III) fluoride	316170010, 1 GR	13765-25-8	99.99
Europium(III) oxide	193020010, 1 GR; 193020050, 5 GR; 193020250, 25 GR	1308-96-9	99.99
Europium(III) sulfate octahydrate	193030010, 1 GR	10031-55-7	99.99
Gadolinium(III) nitrate pentahydrate	202800100, 10 GR; 202800500, 50 GR; 202802500, 250 GR	52788-53-1	99.999
Gallium	193070010, 1 GR; 193070050, 5 GR; 193070250, 25 GR	7440-55-3	99.9999
Gallium(III) nitrate hydrate	212440010, 1 GR; 212440050, 5 GR; 212440250, 25 GR; 212441000, 100 GR	69365-72-6	99.9998
Germanium	193110010, 1 GR; 193110100, 10 GR; 193110500, 50 GR	7440-56-4	99.999
Germanium dioxide	190000100, 10 GR; 190000500, 50 GR	1310-53-8	99.999
Germanium tetrachloride	197150050, 5 GR; 197150250, 25 GR; 197151000, 100 GR	10038-98-9	99.99
Gold	437140010, 1 GR; 437140050, 5 GR	7440-57-5	99.999
Hafnium(IV) oxide	193140010, 1 GR; 193140050, 5 GR	12055-23-1	99.99
Hexaamminecobalt(III) chloride	192870050, 5 GR; 192870100, 10 GR	10534-89-1	99.999
Hydrogen hexachloroplatinate hydrate	437200010, 1 GR; 437200050, 5 GR	26023-84-7	99.999
Hydrogen tetrachloroaurate hydrate	437170010, 1 GR; 437170050, 5 GR	27988-77-8	99.999
Indium	193180050, 5 GR; 193180250, 25 GR	7440-74-6	99.999
Indium(III) acetate	436980100, 10 GR; 436980500, 50 GR	25114-58-3	99.99
Indium(III) bromide	389030100, 10 GR; 389030500, 50 GR	13465-09-3	99.99
Indium(III) chloride	193190100, 10 GR; 193190500, 50 GR; 193192500, 250 GR	10025-82-8	99.995
Indium(III) iodide	316010010, 1 GR; 316010050, 5 GR; 316010250, 25 GR	13510-35-5	99.998
Indium(III) oxide	193170050, 5 GR; 193170250, 25 GR	1312-43-2	99.9997

Ultra Pure Inorganics

PRODUCT DESCRIPTION	PRODUCT CODE	CASNO	% PURITY
Iron	437110050, 5 GR; 437110250, 25 GR	7439-89-6	99.995
Iron(III) nitrate nonahydrate	436810250, 25 GR	7782-61-8	99.9995
Iron(III) oxide	193260100, 10 GR; 193260500, 50 GR; 193262500, 250 GR	1309-37-1	99.999
Lanthanum chloride heptahydrate	193271000, 100 GR; 193275000, 500 GR	10025-84-0	99.99
Lanthanum(III) nitrate hexahydrate	193280050, 5 GR; 193281000, 100 GR; 193285000, 500 GR	10277-43-7	99.999
Lanthanum(III) oxide	193291000, 100 GR; 193295000, 500 GR	1312-81-8	99.99
Lead telluride	277610050, 5 GR: 277610250, 25 GR	1314-91-6	99.99
Lead(II) acetate trihydrate	317230050, 5 GR; 317230250, 25 GR	6080-56-4	99.999
Lead(II) fluoride	212520250, 25 GR	7783-46-2	99.99
Lead(II) nitrate	193320100, 10 GR; 193320500, 50 GR	10099-74-8	99.999
Lithium bromide	212530250, 25 GR; 212532500, 250 GR	7550-35-8	99.999
Lithium carbonate	193360100, 10 GR; 193361000, 100 GR	554-13-2	99.999
Lithium nitrate	212540050, 5 GR; 212540250, 25 GR; 212541000, 100 GR	7790-69-4	99.999
Lutetium(III) oxide	193400010, 1 GR	12032-20-1	99.99
Magnesium nitrate hexahydrate	193420100, 10 GR; 193420500, 50 GR	13446-18-9	99.9995
Magnesium oxide	193430100, 10 GR; 193430500, 50 GR	1309-48-4	99.99
Manganese acetate tetrahydrate	212560500, 50 GR	6156-78-1	99.999
Manganese(II) oxide	436970010, 1 GR; 436970100, 10 GR	1344-43-0	99.99
Mercury	193480500, 50 GR; 193482500, 250 GR	7439-97-6	99.999
Molybdenum(VI) oxide	193530050, 5 GR; 193530250, 25 GR	1313-27-5	99.999
Neodymium(III) nitrate hexahydrate	202810025, 2.5 GR	16454-60-7	99.99
Neodymium(III)-oxide	193560100, 10 GR; 193560500, 50 GR	1313-97-9	99.999
Nickel	436780500, 50 GR	7440-02-0	99.999
Nickel(II) chloride	378350050, 5 GR; 378350250, 25 GR	7718-54-9	99.999
Nickel(II) chloride hexahydrate	193570050, 5 GR; 193570250, 25 GR; 193571000, 100 GR	7791-20-0	99.9999
Niobium(V) oxide	193630100, 10 GR; 193630500, 50 GR; 193632500, 250 GR	1313-96-8	99.99
Palladium	437020010, 1 GR; 437020050, 5 GR	7440-05-3	99.995
Palladium(II) chloride	369670010, 1 GR; 369670050, 5 GR; 369670250, 25 GR	7647-10-1	99.999
Palladium(II) oxide	193680010, 1 GR; 193680050, 5 GR	1314-08-5	99.999
Perrhenic(VII)acid	316180050, 5 GR; 316180250, 25 GR	13768-11-1	99.99
Phosphorus, red	318240050, 5 GR; 318240250, 25 GR	7723-14-0	99.999
Platinum	193710010, 1 GR	7440-06-4	99.999
Potassium bromide	436950100, 10 GR; 436950500, 50 GR	7758-02-3	99.999
Potassium chloride	268960250, 25 GR; 268961000, 100 GR	7447-40-7	99.999
Potassium fluoride	146000050, 5 GR; 146000250, 25 GR	7789-23-3	99.99
Potassium hydrogen phthalate	177121000, 100 GR; 177125000, 500 GR; 177120025, 2.5KG	877-24-7	99.99
Potassium hydroxide	437131000, 100 GR; 437135000, 500 GR	1310-58-3	99.99
Potassium iodide	193790100, 10 GR; 193790500, 50 GR; 193792500, 250 GR	7681-11-0	99.995
Potassium nitrate	193800100, 10 GR; 193800500, 50 GR; 193802500, 250 GR	7757-79-1	99.999
Potassium tetrachloroplatinate	437030010, 1 GR; 437030050, 5 GR	10025-99-7	99.99
Potassium tetraiodomercurate(II)	391090010, 1 GR; 391090050, 5 GR	7783-33-7	99.99
Rhodium(III) chloride hydrate	437092500, 250MG; 437090010, 1 GR	20765-98-4	99.99
Rubidium chloride	193920100, 10 GR; 193920500, 50 GR	7791-11-9	99.99

PRODUCT DESCRIPTION	PRODUCT CODE	CASNO	% PURITY
Scandium(III) oxide	193960010, 1 GR; 193960050, 5 GR	12060-08-1	99.999
Selenious acid	437120500, 50 GR	7783-00-8	99.999
Selenium(IV) oxide	193980100, 10 GR; 193980500, 50 GR	7446-08-4	99.999
Silicon dioxide	437150050, 5 GR; 437150200, 20 GR; 437151000, 100 GR	60676-86-0	99.999
Silver chloride	194040010, 1 GR; 194040050, 5 GR; 194040250, 25 GR	7783-90-6	99.9999
Silver iodide	194060100, 10 GR	7783-96-2	99.999
Sodium carbonate	436800050, 5 GR; 436800250, 25 GR	497-19-8	99.999
Sodium chloride	437040050, 5 GR; 437040200, 20 GR; 437041000, 100 GR	7647-14-5	99.999
Sodium iodide	212680010, 1 GR; 212680100, 10 GR; 212681000, 100 GR	7681-82-5	99.999
Sodium nitrate	437160100, 10 GR; 437160500, 50 GR	7631-99-4	99.999
Sodium thiosulfate pentahydrate	436940250, 25 GR; 436941000, 100 GR	10102-17-7	99.999
Strontium chloride	369740050, 5 GR; 369740250, 25 GR	10476-85-4	99.99
Sulfur	199930100, 10 GR; 199930500, 50 GR; 199932500, 250 GR	7704-34-9	99.999
Tantalum(V) chloride	203910050, 5 GR; 203910250, 25 GR; 203911000, 100 GR	7721-01-9	99.99
Tantalum(V) oxide	194170100, 10 GR; 194170500, 50 GR	1314-61-0	99.99
Tellurium	437010250, 25 GR; 437011000, 100G	13494-80-9	99.999
Tellurium(IV) oxide	318120050, 5 GR	7446-07-3	99.9995
Terbium(III) nitrate pentahydrate	202820020, 2 GR	57584-27-7	99.999
Terbium(III, IV) oxide	194210020, 2 GR; 194210100, 10 GR	12037-01-3	99.999
Tetraammineplatinum(II) chloride hydrate	437005000, 500MG; 437000050, 5 GR	108374-32-9	99.999
Tetrakis(dimethylamino)titanium	353560050, 5 GR; 353560250, 25 GR	3275-24-9	99.99
Thallium(I) nitrate	194240100, 10 GR	10102-45-1	99.999
Thulium(III)-sulfate octahydrate	194290050, 5 GR	13778-40-0	99.99
Tin	325840010, 1 GR	7440-31-5	99.999
Tin(IV) chloride	203380500, 50 GR	7646-78-8	99.999
Titanium(IV) oxide	194340010, 1 GR; 194340050, 5 GR; 194340250, 25 GR	13463-67-7	99.999
Tris(triphenylphosphine)rhodium(I) chloride	194572500, 250MG; 194570010, 1 GR; 194570050, 5 GR	14694-95-2	99.99
Ytterbium(III) chloride hexahydrate	437180100, 10 GR; 437180500, 50 GR	10035-01-5	99.999
Ytterbium(III) oxide	264300100, 10 GR	1314-37-0	99.99
Yttrium fluoride	299770050, 5 GR; 299770500, 50 GR	13709-49-4	99.99
Yttrium(III) chloride hexahydrate	194470100, 10 GR	10025-94-2	99.999
Yttrium(III) oxide	194480020, 2 GR; 194480100, 10 GR; 194480500, 50 GR	1314-36-9	99.999
Zinc	194500050, 5 GR; 194500500, 50 GR	7440-66-6	99.9999
Zinc bromide	212770025, 2.5 GR; 212770100, 10 GR; 212770500, 50 GR	7699-45-8	99.999
Zinc chloride	318170100, 10 GR; 318170500, 50 GR	7646-85-7	99.99
Zinc iodide	212760050, 5 GR; 212760250, 25 GR	10139-47-6	99.999
Zinc oxide	315790250, 25 GR; 315791000, 100 GR	1314-13-2	99.999
Zinc selenide	223640100, 10 GR; 223640250, 25 GR	1315-09-9	99.99
Zinc sulfide	223650250, 25 GR; 223651000, 100 GR; 223655000, 500 GR	1314-98-3	99.99
Zirconium sulfate tetrahydrate	194550250, 25 GR	7446-31-3	99.99
Zirconyl chloride hydrate	388470100, 10 GR; 388470500, 50 GR	15461-27-5	99.99



Find out more at **www.thermofisher.in/chemicals**

Thermo Fisher Scientific India Pvt. Ltd.
403-404, Delphi 'B' Wing, Hiranandani Business Park, Powai, Mumbai - 400 076.
Phone No.: 022-6680 3000 | Fax: 022-6680 3001/2
India Toll Free No.: 1-800-222-230
Email : Lsi_marketing@thermofisher.com

ThermoFisher SCIENTIFIC