

MEDSTERN CANADA LLP



RELIABLE. AUTHENTIC.

EDITION
SUMMER 2025



Superalloys: Rhenium (Re) is a key component in second and third-generation superalloys, crucial for, e.g., power plants. It reduces creep rates through solid solution strengthening and influences the formation of strengthening phases.

RELIABLE RHENIUM

Cornerstone of Industry, Innovation

CLEAN ENERGY

Fuel-cell-powered Micro-CHP Systems can be used to generate both heat and electricity. Rhenium compounds and alloys are beneficial due to their catalytic and structural roles in fuel cell technology. Nickel-Rhenium alloys also improve the high-temperature strength of gas turbine-based CHP system components.

AMMONIUM PERRHENATE NH_4ReO_4

Ammonium Perrhenate is the primary commercial form in which rhenium is traded. It is used as a precursor for producing rhenium metal and various rhenium-based catalysts, and materials.

HYDROCARBON INDUSTRY

High-Octane Gasoline Production



Platinum-rhenium bimetallic catalysts are widely used in catalytic reforming, a process that upgrades low-octane petroleum ether into high-octane gasoline. The platinum primarily acts as a dehydrogenation and hydrogenation catalyst, while Re stabilizes the catalyst, preventing Pt sintering and formation of unwanted carbon deposits.

LABORATORY SCIENCE

Mass Spectrometry, Pharmaceuticals



Rhenium filaments are frequently used in mass spectrometry for thermal ionization due to their excellent mechanical stability and ability to withstand high temperatures. Mass spectrometry (MS) is a versatile analytical technique widely used in drug discovery, environmental monitoring, the food industry, and manufacturing.

INVESTMENT OPPORTUNITIES



Sustainable Mining, Metals, and Galvanic Industries

Canada boasts a diverse range of minerals, including traditional commodities like base metals, as well as critical minerals. The country is home to a large number of mining companies and is a leading destination for international mining finance. Foreign direct investment (FDI) in the Canadian mining sector was \$65.1 billion in 2022.

Status 2024/2025

ACCESS RESOURCES, GROW SUPPLY BASE



**MINES, MINERAL
DEPOSITS**

**METAL, GALVANIC
INDUSTRIES**

**LOGISTIC
INFRASTRUCTURE**

Including extraction, services, primary and downstream manufacturing, the Canadian Mining and Metals Sector contributed a total of \$108.5 billion to GDP in 2022. Canada has a well-established mining sector with a supportive regulatory framework, including established stock exchanges. Investors who can guarantee offtake agreements contribute significantly to the economy. Reliable and robust technologies are the key to leaving behind only clean water, healthy landscapes, and achieving greater competitive strength through value-added mining and metal commodities.

AUTHENTIC RHENIUM

Physical and Chemical Properties

186.207	75
[Xe]4f ¹⁴ 5d ⁵ 6s ²	
Re	
Transition Metal RHENIUM	

Atomic Structure, Rhenium, Re

Electron Affinity	14.5 kJ/mol	Electronegativity (Pauling)	1.90
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Periodic Table of the Elements

Rhenium, Re

Period 6

Group 7

Physical Properties, Rhenium, Re

Density at 20 °C

21020 kg/ m³

Spec. Heat Capacity

137 J/ (kg * K)

Melting point

3459K, 3186 °C

Boiling point

5869 K, 5596 °C

Isotopes, Rhenium, Re

¹⁸⁵Re

¹⁸⁷Re

184.9529 u

186.9557 u

PHYSICAL



Appearance: Silvery-white, dense metal
Crystal Structure: Hexagonal close-packed (hcp)
Hardness: 7.0 Mohs Scale, depending on purity
Malleability: Can be hammered into thin sheets
Conductivity: good conductivity
Young's Modulus: 463 GPa

CHEMICAL



Corrosion Resistance: excellent resistance to corrosion in many environments, high temperature
Thermal Expansion (25°C): 6.2 μm (m⁻¹ · K⁻¹)
Common Oxidation States: from -3 to +7
Rhenium Compounds: e.g., Rhenium (VII) Oxide (Re₂O₇), Rhenium trioxide (ReO₃), Ammonium Perrhenate (NH₄ReO₄)...

RHENIUM-BEARING MINERALS

Mining Industry, Raw Materials

Powellite

(CaMoO_4)



Calcium Molybdate
Strunz:
7.GA.05

Rheniite

(ReS_2)



Sulfide Mineral
Strunz:
2.EB.35

Molybdenite

(MoS_2)



Molybdenum disulfide
Strunz:
2.EA.30

Columbite

((Fe,Mn) Nb_2O_6)



Iron-Manganese Oxide
Strunz:
4.DB.35

FROTH FLOTATION

Ore Preparation Phase: From Gangue Material to Molybdenum Disulfide Ore Concentrate

Crushing

Grinding

Classification

Beneficiation

- ☐ Jaw-, Cone-, Impact Crushers, Ball Mills
- ☐ Smaller sized rocks, finer fragments

- ☐ Hydrocyclones, screens
- ☐ Froth flotation, gravity spirals
- ☐ Molybdenum content in mined ore, 0.01 - 0.25% Mo

Froth Flotation Process

- ☐ Slurry Preparation
- ☐ Aeration, foam layer skimming, dewatering
- ☐ Making MoS_2 -containing particles hydrophobic
- ☐ Addition of water, collectors, e.g., kerosene, diesel oil, xanthates, frothers, e.g., methyl isobutyl carbinol
- ☐ MoS_2 concentrate often > 57 % Mo

RHENIUM PROCESSING

The Metal and Galvanic Industries

From MoS₂ to Rhenium (VII) oxide (Re₂O₇)

Oxidative Roasting

- Molybdenite concentrate (MoS₂) □ Temp: 500 – 700 °C □ (Re₂O₇) in roaster dust, flue dust, and fly ash
- $2\text{MoS}_2 + 7\text{O}_2 \rightarrow 2\text{MoO}_3 + 4\text{SO}_2$ □ $4\text{ReS}_2 + 15\text{O}_2 \rightarrow 2\text{Re}_2\text{O}_7 + 8\text{SO}_2$ □ E.g., gaseous rhenium (VII) oxide (Re₂O₇) in SO₂ stream

The gas stream composition is determined by factors such as temperature, oxygen partial pressure, presence of other reactants and is measured using precision gas sensors. The process layout configuration and selection of the adsorbent material, dependent on the gas stream composition of rhenium-bearing compounds, including ReS₂, Re₂S₇, ReO₂, Re₂O₇, etc.

From Rhenium (VII) oxide (Re₂O₇) to Rhenium trioxide (ReO₃)

Redox Reaction

Pressing

Sintering

- $\text{Re}_2\text{O}_7 + \text{CO} \rightarrow 2\text{ReO}_3 + \text{CO}_2$ □ Compacting via Powder Injection Molding (PIM) □ Rhenium trioxide, ReO₃: > 99.9% grade
- Temp: 200 °C, CO reducing agent □ ReO₃ powder □ Temp: 300 - 400 °C, vacuum-arc furnace □ shaped parts, e.g., tablets

Wet scrubber: multiple-stage, gas-liquid scrubbing columns, from (Re₂O₇) to Ammonium Perrhenate, NH₄ReO₄

Leaching

Filtration

Evaporation

Sorption

Precipitation

Filtration

- $\text{Re}_2\text{O}_7 + \text{H}_2\text{O} + 2\text{NH}_3 \rightarrow 2\text{NH}_4\text{ReO}_4$ □ Processing to liquid concentrate □ Scrubbing liquid □ Ammonium Perrhenate, NH₄ReO₄
- Temp: 80 - 90 °C, NH₃-containing water □ Supersaturated NH₄ReO₄ □ Sorbent material, filler □ Precipitant □ Crystals

Metallic Rhenium (Re) Manufacturing

Input material: Ammonium Perrhenate, NH₄ReO₄

TRANSPORTATION SUPPORT SERVICES

Supply Chain Integration



Tailored logistics support services are available to B2B Partners, outsourcing their supply chain needs, including secure storage in warehouses, freight rail transportation, and specialized service providers for cargo handling and management, to ensure products get to market on time and within budget.



MODES OF TRANSPORTATION

- Trucks: for short distance hauls and last-mile delivery
- Trains: for long-distance transport of products, goods
- Ships: for large volumes of commodities via ocean freight

TRANSLOADING FACILITIES

- Access to distribution centers, warehouses, and storage space
- Secure transfer of commodities between modes of transportation, e.g., rail-to-ship

LOGISTICS SUPPORT SERVICES

- Optimized shipping processes, analysis, including route planning, cost calculation, carrier identification, shipment tracking, and tracing for precision, real-time product movement

RHENIUM PRODUCT FORMATS

Industrial Formats for Rhenium, Re

Tailored product formats can be made accessible to B2B Partners, based on achieved off-take agreements. The highlighted products on this page are a selection of possible product alternatives available for trade.

Rhenium trioxide, ReO_3 Powder, Tablets		Ammonium Perrhenate, NH_4ReO_4 Powder, crystalline Granules	
			

Sheets, Flats	Foils	Rods	Ingots
			

Rhenium-Platinum Alloys, Pt-Re	Rhenium-Nickel, Alloys, Ni-Re	more applications...	
			

RHENIUM COMMODITIES

Classes and Standards

High-Purity Rhenium

- ☐ **High-Purity Rhenium, unalloyed**
 - ☐ CAS# 7440-15-5 | Re
 - ☐ Ingots, bars, wires, flakes, foils
 - ☐ Purity $\geq$ 99.999%, 5N Very High Purity
 - ☐ Purity $\geq$ 99.99%, 4N High Purity
 - ☐ Purity $\geq$ 99.9%, 3N High Purity

Chemical compounds

- | | |
|--|---|
| <ul style="list-style-type: none">☐ High-Purity APR, NH_4ReO_4<ul style="list-style-type: none">☐ CAS# 13598-65-7 NH_4ReO_4☐ Powders, crystalline granules, crystals☐ Purity $\geq$ 99.999%, 5N Very High Purity☐ Purity $\geq$ 99.99%, 4N High Purity☐ Purity $\geq$ 99.9%, 3N High Purity☐ Purity $\geq$ 99.0%, 2N Trace metals basis | <ul style="list-style-type: none">☐ High-Purity Rhenium trioxide, ReO_3<ul style="list-style-type: none">☐ CAS# 1314-28-9 ReO_3☐ Powders, Tablets☐ Purity $\geq$ 99.999%, 5N Very High Purity☐ Purity $\geq$ 99.99%, 4N High Purity☐ Purity $\geq$ 99.9%, 3N High Purity☐ Purity $\geq$ 99.0%, 2N Trace metals basis |
|--|---|

Rhenium-based alloys

- | | |
|--|---|
| <ul style="list-style-type: none">☐ Rhenium-Nickel Alloys, Re-Ni<ul style="list-style-type: none">☐ DIN 17740:2002-09: Ni content in alloys☐ Wires, sheets, tubes | <ul style="list-style-type: none">☐ Rhenium-Platinum Alloys, Pt-Re<ul style="list-style-type: none">☐ PtRe14, Pt53Re47☐ Electrical contact materials, Pt-Re catalysts☐ ISO 11494: Pt content in alloys |
|--|---|

Other Standard Measurements

- | | |
|--|---|
| <ul style="list-style-type: none">☐ ASTM B329, Metal Powders Density<ul style="list-style-type: none">☐ Rhenium, CAS# 7440-15-5 Re☐ Ammonium Perrhenate (APR), NH_4ReO_4☐ Rhenium trioxide, CAS# 1314-28-9 ReO_3 | <ul style="list-style-type: none">☐ Measurement Standards<ul style="list-style-type: none">☐ DIN 17034, ISO/IEC 17025, Laboratories☐ DIN EN ISO 17294-2:2017-01: Environmental |
|--|---|

GLOSSARY

Abbreviations, Definitions

Froth Flotation	a mineral processing technique that separates valuable materials from tails based on differences in their surface properties, specifically their hydrophobicity (water-repelling) or hydrophilicity (water-attracting).
Electric Arc Furnace	a furnace that uses an electric arc to heat and melt metals, by passing an electric current through them. Key components are a furnace chamber, electrodes (e.g. graphite), a power source, and a system for charging and discharging the furnace.
Scrubber Columns	are devices used to remove pollutants or valuable minerals from exhaust gases, and they can utilize either absorption or adsorption.
Standardization Institutes	ISO: International Organization for Standardization EN: European Norm/ Standard ASTA: American Society for Testing Materials DIN: Deutsches Institut für Normung

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