

MEDSTERN CANADA LLP



RELIABLE. AUTHENTIC.

EDITION
SUMMER 2025



RELIABLE PALLADIUM

**Automotive, Chemical, Electroplating,
Medical, Environmental Technology**

Excellent catalytic activity in automotive emission control and chemical synthesis, high corrosion, wear, and oxidation resistance for durable components are key technical benefits.

AUTOMOTIVE, CATALYTIC CONVERTERS

Palladium (Pd) speeds up chemical reactions in exhaust gases without being chemically changed itself. It is highly effective for gasoline engines due to its high temperature resistance and catalytic ability, and can withstand the harsh conditions inside an exhaust system. By converting pollutants, it significantly reduces vehicle emissions and improves air quality.

PALLADIUM ALLOYS NI-AG-CU

Pd-Ni alloys are the choice of preference in many catalysts for gas purification, chemical sensing, and fuel cell development. Pd-AG alloys leverage of palladium's catalytic power with silver's cost-effectiveness and higher selectivity. Pd-CU alloys are used in wire bonding and for multi-layer capacitors in various electronic applications such as navigation displays and radios.



CHEMICAL INDUSTRY

Petroleum-based liquid fuels, Fine Plastics



In the chemical industry, palladium is a vital catalyst used to accelerate and initiate chemical reactions, particularly in industrial processes like hydrogenation, where it converts unsaturated hydrocarbons into more useful products such as fine plastics, and specialty chemicals. Palladium speeds up the refining of crude oil into products like gasoline, diesel, jet fuel, and ethanol.

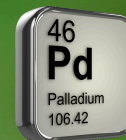
ELECTROPLATING

Stainless-Steel, Jewelry, Brass



Palladium creates a durable, hard, and corrosion-resistant white-gray finish on various substrates like sterling silver, brass, and steel. Palladium offers excellent scratch-resistance and may be plated over base metal or other coatings such as nickel. It is used in jewelry for durability and corrosion resistance. Palladium-Nickel alloys provide wear resistance to connectors.

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 PALLADIUM

Physical and Chemical Properties

Atomic Structure, Palladium, Pd

Electron Affinity	53.7 kJ/mol	Electronegativity (Pauling)	2.20
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Periodic Table of the Elements

Palladium, Pd

Period 5

Group 10

Physical Properties, Palladium, Pd

Density at 20 °C 12020 kg/ m³

Spec. Heat Capacity 240 J/ (kg * K)

Melting point 1828.05 K, 1554.9 °C

Boiling point 3236 K, 2963 °C

Isotopes, Palladium, Pd

¹⁰² Pd	¹⁰⁴ Pd	¹⁰⁵ Pd	¹⁰⁶ Pd	¹⁰⁸ Pd	¹¹⁰ Pd
101.9056 u	103.9040 u	104.9051 u	105.9035 u	107.9039 u	109.9052 u

PHYSICAL



Appearance: lustrous, silver-white metal

Crystal Structure: face-centered cubic (FCC)

Hardness: 4.75 – 5 Mohs Scale, depending on purity

Malleability: highly malleable

Conductivity: very good electrical conductivity

Young's Modulus: 121 GPa

CHEMICAL



Corrosion Resistance: excellent resistance, can corrode when in contact with aqua regia, etc.

Thermal Expansion (25°C): 11.8 µm (m⁻¹ · K⁻¹)

Common Oxidation States: +2, 0, +4, also +1, +3

Palladium Compounds: e.g., Palladium (II) chloride (PdCl₂), Chloropalladic (IV) acid, (H₂PdCl₆), Ammonium hexachloropalladate (IV) (NH₄)₂PdCl₆).

PALLADIUM MINERALS AND PROCESSING

Mining, Metal, and Galvanic Industries, Raw Materials

Cooperite

(Pt,Pd,Ni)S



PGE sulfides

Strunz:

2.CC.35b

Merenskyite

(Pd,Pt) (Te,Bi)₂



Telluride mineral

Strunz:

2.EA.20

Naldrettite

(Pd₂Sb)



Sulfide mineral

Strunz:

2.AC.25a

Braggite

(Pt,Pd,Ni)S



PGE sulfides

Strunz:

2.CC.35a

Ore Preparation Phase: From Gangue Material to Palladium Concentrate

Crushing

Wet Grinding

Classification

Beneficiation

- ☐ Jaw-, cone-, impact crushers
- ☐ Wet mills, steel ball mills
- ☐ Screening of coarser particles
- ☐ Pd slurry preparation for froth flotation
- ☐ 1.5 to 10g/t Pd content, head grade in Pd rich ore deposits
- ☐ Vibrating screens, -200 mesh
- ☐ Gravity separation, magnetic separation

Froth Flotation Process

- ☐ Conditioning in flotation cells, stainless steel tanks
- ☐ Making Pd particles hydrophobic
- ☐ Mechanical agitation, air injection
- ☐ Dewatering
- ☐ Addition of water, collectors, e.g. diethyl xanthogen, frothers, e.g. polypropylene glycol methyl ether
- ☐ up to 100g/t Pd content in Pd concentrate

PGM Concentration Process: From Pd concentrate to Ni-Cu-PGM matte

Smelting

Conversion

- ☐ Temp: up to 2000°C, electric furnace
- ☐ Iron Oxidation: $2\text{FeS} + 3\text{O}_2 \rightarrow 2\text{FeO} + 3\text{SO}_2$
- ☐ Slow cooling, crystallization to PGM-rich concentrate, milling
- ☐ PGM-rich matte, molten layer incl., Fe-Ni-Cu
- ☐ Removal waste slag, FeO, SO₂
- ☐ Creation of Ni-Cu-PGM matte, also higher-grade "white metal"

From PGM-rich matte to solid ammonium hexachloropalladate (IV), (NH₄)₂PdCl₆

Chemical Leaching

Pt Precipitation

Decantation, Filtration, Washing

- ☐ Dissolution PGM-rich matte, e.g. via aqua regia, up to 135°C
- ☐ Oxidation Cl₂, Ammonium Chloride (NH₄Cl)
- ☐ Formation Pd salt crystal, precursor Pd sponge
- ☐ Removal of dissolved base metals
- ☐ $[\text{PdCl}_4]^{2-} + \text{Cl}_2 \rightarrow [\text{PdCl}_6]^{2-}$, Hexachloropalladate (IV) complex
- ☐ Ammonium hexachloropalladate (IV), ((NH₄)₂PdCl₆)

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

PALLADIUM PRODUCT FORMATS

Industrial Formats for Palladium, Pd

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.

Ammonium Hexachloropalladate (IV), $(\text{NH}_4)_2\text{PdCl}_6$ Chloropalladic (IV) acid, $(\text{H}_2\text{PdCl}_6)$		Powder	Sponge
			

Ingots, Cast Bars	Bullions	Rods	Tubes
			

Wires	Granules	Coatings, Thin Films	
			

PALLADIUM COMMODITIES

Classes and Standards

High-Purity Palladium

- ☐ **High-Purity Palladium, unalloyed**
- ☐ ASTM B589-94 (2021), refined Pd,
 - ☐ Sponge, cast bar, and wrought forms
 - ☐ Purity $\geq 99.99\%$, 4N, Specialized Coatings
 - ☐ Purity $\geq 99.95\%$, 3N5, Catalysts, Fuel Cells
 - ☐ LBMA/LPPM, good delivery, certified bars
 - ☐ Purity $\geq 99.90\%$, 3N, Electronics

Palladium Alloys

- ☐ **Palladium-Nickel Alloys, Pd-Ni**
- ☐ ASTM B867 for electrodeposited coatings, engineering, industrial and electrical contact alloys
 - ☐ e.g., 75% Pd/25% Ni, 90% Pd/10% Ni
- ☐ **Palladium-Silver-Copper Alloys, Pd-Ag-Cu**
 - ☐ ASTM B563, B683 for electrical contacts
 - ☐ Wire, rod, strip, and sheet forms

Palladium Powder

- ☐ **High-Purity Palladium, Powder**
- ☐ ASTM B329, Metal Powders Density
- ☐ E.g., Additive Manufacturing, engineering materials, purity grades 3N, 4N, 5N, etc.
- ☐ ISO/ASTM, 52928, 52900-2018, 52904, AM Powder Metallurgy

Palladium Electroplating

- ☐ **Palladium Electroplating, Pd Electrodeposition**
- ☐ Standard industrial requirements
 - ☐ ASTM B679, B799 for electrodeposited Pd coatings
 - ☐ Purity $\geq 99.70\%$, min. Pd content, porosity

Measurement Standards

- ☐ **Other Measurement Standards**
- ☐ ASTM E1004, Palladium materials
- ☐ EN ISO 11495:2019, Palladium alloys
- ☐ NIST SRM 3138, Solution, Analytical Inst.
- ☐ DIN 17034, ISO/IEC 17025, Laboratories
- ☐ DIN ISO 14577, Material parameters
- ☐ DIN EN ISO 17294-2:2017-01, Water

Palladium Catalysts

- ☐ **Palladium Catalysts, Pd**
- ☐ ASTM D4782, ASTM D5153 – Standard test methods Pd in molecular sieve catalysts, fresh catalysts, wet chemistry, atomic absorption, etc.

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).
PGM	Platinum Group Metals: These are six similar elements: platinum (Pt), palladium (Pd), rhodium (Rh), ruthenium (Ru), osmium (Os), and iridium (Ir). They are highly valued for their corrosion resistance, catalytic properties, and use in jewelry, industry, and electronics.
Catalytic Converter	an exhaust emission control device in vehicles that converts harmful pollutants from the engine into less harmful substances. It uses a ceramic honeycomb coated with precious metals like platinum, palladium, and rhodium to catalyze these redox reactions, reducing the environmental impact of vehicle emissions.
Electroplating Projects	the process of using a direct electric current to coat a metal object with a thin layer of another metal, typically to improve wear resistance or prevent corrosion. When electricity flows, the dissolved metal ions in the electrolyte solution are attracted to the cathode, accept electrons, and deposit as a consistent, solid metal coating.
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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