Recycling of Precious Metals via an Efficient Process with no Toxic Byproduct

(No. T4-1670)

Principal investigator

Igor Lubomirsky

Faculty of Chemistry
Department of Molecular Chemistry and Materials Science

Overview

Platinum group metals (PGM) are well-known precious metals that play an important role in many industrial applications as catalysts. Current methods for their recycling are not efficient, require extreme conditions, and involve toxic reagents or byproducts. Prof. Igor Lubomirsky and his team developed a method for efficient and environmentally benign recovery of precious materials that are currently discarded in large quantities from spent catalysts (automotive and industrial) from industrial processes (particularly in the electronic industry). The process is based on volatilization for selective extraction of precious and rare metals using benign metal salts rather than dangerous chlorine gas as a chlorinating agent. The new process requires relatively low temperatures and is free from hazardous waste, among its additional advantages over conventional methods. We believe that this efficient technology is key to increased reclaimed precious metals output, potentially reducing the demand for primary rare metals.

The Need

PGM, e.g., platinum (Pt), palladium (Pd), and rhodium (Rh), are well-known precious metals playing an important role in many industrial applications such as jewelry and ornaments, electronics, telephone circuits, dental alloys, etc. Platinum and palladium have also long been used as reforming and hydrogenation catalysts in the petroleum or automobile industries, respectively. In catalysts, small amounts of platinum or palladium are contained in large volumes of support materials, typically as a metal coat supported on alumina, zirconia, or silica.

Current methods for recycling platinum and palladium in spent petroleum or automobile industry catalysts include hydrometallurgical extraction that results in enormous quantities of hazardous waste and pyrometallurgical techniques that are not efficient as standalone processes and are typically done within metal smelters. An additional method is volatilization recovery of PGM, which is performed using toxic chlorine gas at high temperatures (typically at 1,200C^{o}).

Therefore, there is a need for a safe method for PGM recovery with low environmental impact, high selectivity, and efficiency in mild conditions. The optimal method would be easily industrialized on different scales and result in a high yield of the recovered metals.

The Solution

Technology Essence:

Prof. Igor Lubomirsky and his group developed a novel method for PGM recovery from spent catalysts that can also be applied to other spent systems.

The method comprises crushing the spent catalyst to obtain a particulate catalyst material with a predetermined grain size and reacting it with chlorine-containing salts rather than pure chlorine gas in a furnace at relatively low temperatures (900 C^{o}, far below the temperature required in the conventional volatilization method). This is

followed by cooling the volatile PMG chloride product and converting it into solid-phase metal.

Advantages

- No toxic input - chlorides are used rather than chlorine gas
- No hazardous waste is generated in the process
- Mild conditions. High-temperature furnaces and equipment are not required
- Relatively simple setup in comparison to conventional ones
- Small-scale plants are economically viable

Development Status

- The laboratory-scale setup is operative. Multiple successful experiments have been performed with high yield
- A pilot plant is being planned

Market Opportunity

Practically all modern conventional automobiles are now equipped with a catalytic converter containing PGM. According to a market research report published by Innovative Research and Products, titled GlobalÂ Market for Platinum, Palladium, and Other Platinum Group Metals Recycling - A Global Technology, Industry, andÂ Market Analysis, the global recycling market for these metals is expected to undergo an annualÂ growth of 8.2% and reach $9 billion by 2018

Patent Status

USA Granted: 11,898,220 USA Granted: 10,457,999 USA Granted: 11,473,168