JOHNSON MATTHEY
TECHNOLOGY REVIEW

technology.matthey.com

Guest Editorial

The Continuing Importance of Platinum Group Metals

NON-PEER REVIEWED FEATURE

Received 19th May 2023; Online 8th June 2023

Platinum group metals (pgms) have never been more essential. They are already key contributors to technologies that have global impact: catalytic convertors (platinum, palladium, rhodium) that minimise air pollution; catalysts (platinum, rhodium) to produce nitric acid in fertiliser manufacture, which supports global food production; crucibles (iridium) for making scintillation crystals used in metal scanners and mobile phones; and hard disks (platinum, ruthenium) with enhanced storage capacity.

This special pgm edition of the *Johnson Matthey Technology Review* highlights how some of these long-standing applications are developing. For platinum jewellery, bulk metallic glasses are being investigated for their improved properties compared to cast alloys (1), while the mechanical properties of platinum-rhodium binary alloys and superalloys are being studied based on the impact of the valance electron ratio on metallic bonding (2). Platinum-rhodium alloys are crucial in the production of glass fibres, and here work is presented which investigates additive manufacture as a way to overcome limitations on fabricating equipment (3). The use of additive manufacture is discussed for making platinum-gold alloy jewellery using laser powder bed fusion technology (4).

Catalysis has always been a pivotal application of the platinum group metals, and this special edition features a discussion on progress in C–H activation by rhodium and iridium complexes, a potential future route to making chemical feedstocks from, ideally, sustainably derived hydrocarbons (5). Out of the H2020 Platinum Group Metals Recovery Using Secondary Raw Materials (PLATIRUS) project, novel technologies for improving the recovery of pgms from end-of-life catalysts are reported, including microwave assisted leaching and gas-diffusion electrocrystallisation (6).

Significant advances have been made in the potential environmental impact of pgm-catalysed processes by carrying out reactions in water instead of organic solvents and decreasing the use of energy and reagents. This is exemplified by a room temperature, aqueous electrochemical route for synthesis of monodisperse platinum-cobalt nanocrystalline catalysts (7) and ground-breaking work reported on aqueous micellar catalysis by palladium in water at ambient temperatures (8).

With particular reference to palladium in organic chemistry, the article by Professor Bruce Lipshutz (8) also raises concerns circulating in the academic community about whether there will be enough palladium to meet future demand in organic synthesis. In reality, Johnson Matthey's pgm market insight indicates that palladium and rhodium will go from their current state of high demand and high price into a surplus position as road transport transitions away from the fossil fuel burning internal combustion engines towards zero tailpipe-emission vehicles (9). As a consequence, in upcoming decades there will be significant opportunities to use palladium and also rhodium in organic chemistry and in a range of new and growing applications.

Critical Material Constraints

Looking to the future, a mixture of technologies will be needed to achieve the transition to net zero, many of which feature pgms. Critical material constraints (among others) will necessitate that the transport market be shared between lithium- and cobalt-dependent battery electric vehicles, which are best suited for the shorter distances and lower loads of passenger vehicles, and platinum-containing fuel cell vehicles, which have the ability to transport heavier loads over longer distances with less frequent refuelling. To enable renewable energy (solar power, hydro power, wind power) to be transported from the geographies where they are most plentiful will require iridium- and platinum-based electrolysers; these generate hydrogen which can then be liquified or captured in a carrier (ammonia or a liquid organic) to be transported cheaply and safely to point of use, significantly easing future demands on electrical infrastructure.

The Transition to Net Zero

Both mining and recycling are necessary to supply the quantities of pgms demanded by their ever-increasing range of applications, and the high value of pgms means that both continue to be a commercially viable proposition. While miners and refiners of pgm plan to transition their operations to net zero, one way to minimise the environmental impact of processing pgms is to keep using them for as long as possible. Tracking pgms through a closed-loop recycle has been proven to be the most effective way to minimise metal losses resulting from inefficient collection and increase the useful life of pgms. There would be advantage in applying this model to other critical metals as their recycling intensity increases and availability concerns become more urgent.

As this special edition of the *Johnson Matthey Technology Review* illustrates, pgms have an important and unique contribution to make in addressing current global challenges in energy, food and health and will continue to be essential to the technology portfolio for centuries to come.

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