

Guest Editorial

Platinum Group Metals: Widespread Use As Functional Material

Introduction

Platinum group metals (pgms) have widespread applications as functional materials in many different industries. The applications range from catalytic surfaces or particles, sensors, biomedical imaging or drug delivery systems and thermocouples up to jewellery items that we use for special moments of our life. The pgms are used as solid bulk materials, powders, thin films, organic compounds or liquid dispersions of nanoparticles. This astounding variety of applications of pgm materials is reflected in the current issue of *Johnson Matthey Technology Review*.

Vibrant Research

The production of pgm requires the extraction of pure pgm from multicomponent systems in which their content can vary considerably. Usually a multistep process is required to extract the different pgm in their pure form. Fedoseev *et al.* demonstrate the potential of hydrocarbonyl processes for the extraction of pgm from multicomponent chloride-sulfate solutions of industrial products, such as anode sludges generated during the extraction of cathode copper and nickel.

Metallic nanoparticles find a wide range of applications in sensors, catalysis, biomedical imaging, optochemical sensors, drug delivery systems and designing quantum dots. In most cases nanoparticles of pure metals are used. However, studies show that bimetallic nanoparticles (BMNP) show much higher catalytic capabilities. Therefore, BMNPs have become quite the hot topic for researchers and scientists across various spectra of interests. The work conducted by Kumar Verma *et al.* compares monometallic gold nanoparticles vs. gold/platinum BMNP. The influence of alloying

on the thermal conductivity could have significant implications in various industrial applications.

Thin film coatings of pgm require bulk, high-purity metallic sputter targets. Ruthenium cannot be processed into sheet metal by conventional means due to its hexagonal crystal structure. Powder metallurgy technology is therefore required to produce fully dense substrates. The contribution of Zhang *et al.* demonstrates that the vacuum hot pressing of ruthenium powder can provide fine-grained blankets with mechanical properties close to electron-beam melted ruthenium.

Thermocouples are used by many of us in our daily work and we take it for granted that the correct temperature is shown. The mass loss of pgm under vacuum or air is well known, but studies that consider the actual effect of such evaporation on the accuracy of thermocouples are rare. The study presented in this issue showed that the mass loss in an actual thermocouple geometry was one order of magnitude lower compared to previous studies.

Unique Properties

Gas turbine engines expose construction materials to a combination of high temperature, highly reactive hot combustion gases, high static mechanical loads as well as low and high cycle fatigue. The standard materials for such applications are nickel and iron based superalloys. However, the need to improve turbine efficiency and to reduce CO₂ emissions requires an increase of the operation temperature. Platinum based superalloys have been discussed in the past as potential material for next generation turbines because they provide higher melting temperature and corrosion resistance compared to conventional superalloys. Hu *et al.* review the structural characteristics, mechanical properties,

oxidation resistance and corrosion behaviour of Pt-Al ternary, quaternary and multiple superalloys. Pt-Al-Cr-Ru alloys show the most promising properties and could be used up to a temperature 200 K higher than conventional superalloys.

While the high melting temperature of platinum is a benefit for high-temperature applications, some industries struggle with the challenges implied by the required processing temperatures. The investment casting of high quality and filigree jewellery items still remains a demanding task. Platinum based bulk metallic glasses that are reviewed by Houghton and Greer could provide new production opportunities. Their melting temperature is comparable to karat gold alloys. Above that, they offer the possibility for thermoplastic forming at very low temperature.

Due to their very high hardness, they are supposed to offer greater wear resistance than conventional alloys. The research of platinum bulk metallic glasses offers much open land for further studies of this exciting class of material.

The current issue of *Johnson Matthey Technology Review* reflects the vibrant field of research on pgm based materials that ranges from nanoparticles to bulk materials. This is triggered by the unique properties of these materials that make them inevitable for many technological applications.

ULRICH E. KLOTZ

fem Research Institute Precious Metals + Metals
Chemistry, 73525 Schwaebisch Gmuend, Germany

Email: klotz@fem-online.de