Max-Planck-Innovation

Technology Offer

A process for recycling of noble metals

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Max-Planck-Innovation GmbH
Amalienstr. 33
80799 Munich
Germany

Phone: +49 (89) 29 09 19 - 0
Fax: +49 (89) 29 09 19 - 99
info@max-planck-innovation.de
www.max-planck-innovation.de

Contact
Dr. Wolfgang Tröger
Phone: +49 (89) 29 09 19 - 27
troeger@max-planck-innovation.de

Background

Noble metals are used in various fields of application such as catalysis, jewelry, high technology electronic equipment, equipment for glass industry and many others. As noble metals are rare and hard to extract from the ores or exhausted compounds, many efforts have been undertaken to establish an efficient recycling process. Due to their corrosion resistant properties, noble metals recycling by means of dissolution is limited to the usage of very reactive and harmful chemicals such as Aqua Regia. This leaching process with very high reagent use requires high acid concentration and high temperature and is accompanied by emissions of toxic gases. Therefore, an effective, low priced, safe and environmentally friendly process for noble metal recycling is highly demanded.

Technology

We offer a new environmentally friendly and safe technology to recycle noble metals. An efficient recycling is achieved by exposing noble metal containing materials alternating to oxidative and reductive conditions in the presence of a complexing agent. The usage of low concentrated acid solution, in which selected reductive and oxidative gasses are introduced in a tailored sequence, leads to the dissolution of noble metals. To avoid the re-deposition of noble metal, the dissolution can be stabilized by addition of carbon monoxide and a complexing agent such as chlorides, bromides, iodides or cyanides. Oxygen, peroxide, ozone, nitric acid, which are also effective in removing organic and other carbon based contaminates are good oxidation promoted species. Effective reductive species are e.g. hydrogen, carbon monoxide and methanol. The results of platinum dissolution are shown in the Fig. 1.

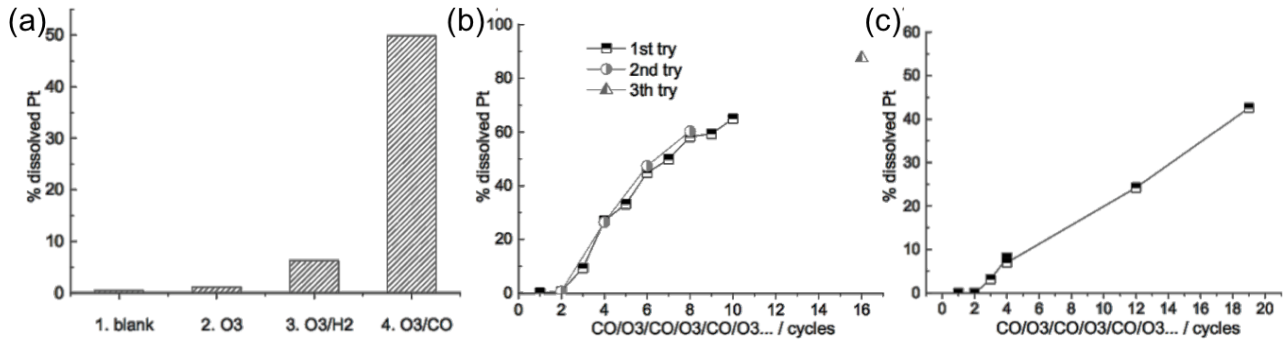

Fig.1: (a) Recycling of platinum from the platinum nanoparticles deposited on high surface area carbon (HSAC) with a 46% metal loading. The influence of presence of argon, O_3, alternating O_3/Ar/H_2 exposure and the alternating O_3/Ar/CO in the mixture of 0.1 M $HClO_4$ and 0.1 M NaCl were investigated. HSACPt-containing material was drop casted as a thin film and dipped into the electrolyte solution, and rotated with 400 rpm. The diagram (a) shows the amount of the dissolved Pt (i) in the presence of Ar for 35 minutes, (ii) in the presence of O_3 for 35 minutes, (iii) in alternately presence of O_3, Ar, O_2, Ar, O_3, Ar, H_2, Ar, 5 minutes each cycle, (iv) in alternately presence of O_3, Ar, CO, Ar, O_3, Ar, CO, 5 minutes each cycle. The diagram (b) shows the amount of dissolved Pt obtained by stirring the HSAC Pt-containing material suspension exposure to: O_3 (20 min), Ar (10 min), CO (10 min), Ar (10 min), O_3 (10 min), Ar (5 min), CI (10 min), Ar (10 min), O_3 (10 min), Ar (5 min) in 0.1 M $HClO_4$. The diagram (c) shows the amount of dissolved Pt obtained by stirring the Car exhaust catalyst suspension exposure to: CO (20 min), Ar (5 min), O_3 (20 min), Ar (5 min), CO (20 min), Ar (5 min), O_3 (20 min), Ar (5 min) in 0.1 M $HClO_4$.

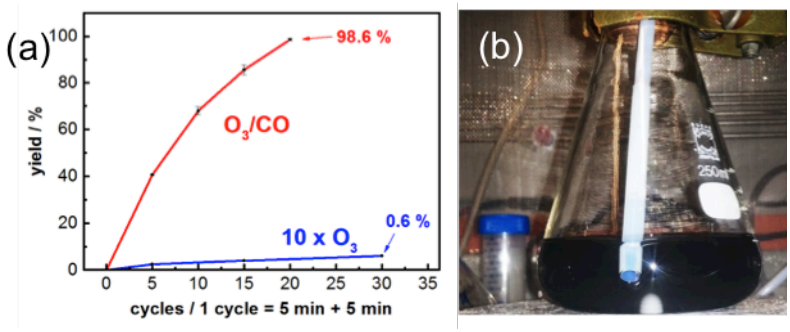

Fig. 2: (a) Pt Black powder suspension Pt yields of CO/ozone and pure ozone treatment in 0.3 M HCl + 1 M NaCl at room temperature. Images of before (b) and after (c) complete dissolution (yellow) of Pt suspension after 20 exchanges between ozone and CO.

The results confirm that platinum can be efficiently dissolved and recycled using the proposed technology.

Advantages

- Safer, more environmentally friendly and cheaper
- Low consumption of reagents and low acid concentration
- Low emission of hazardous gases
- Low process temperatures and pH
- Removal of carbon based surface contaminates
- No oxidative or reductive pre-treatments are required

Patent Information

DE patent application filled in October 2015.