Pt, Pd and Rh recovery from End of Life Products and Nanoparticle Synthesis by Gas-Diffusion Electrocrystallization (GDEx)

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Gas-diffusion electrocrystallization (GDEx) is an electrochemical technology that allows to recover metals in the form of (hydr)oxides or in a zero-valent state, forming nanoparticles (NPs) (Prato Modestino et al., 2020). The electrochemical device to conduct GDEx includes a gas diffusion electrode (GDE) used as a cathode, which allows the percolation of a gas that will be electrochemically reduced within the porous electrode. This results in the formation of oxidizing or reducing species, depending on the gas supplied. When the gas supplied is CO_2, and the medium is aqueous, CO and H_2 are formed, which act as reducing agents, obtaining metallic NPs if the reduction potential of the metal ion species in solution is sufficiently high.

The platinum group metals (PGMs) are widely used due to their catalytic properties in the automotive, chemical manufacture and petroleum refining industries. Due to their economic importance and potential supply risks, they have been denoted as critical raw materials by the European Commission (European-Commission. Directorate-General for Internal Market, 2017). Hence, recycling the PGMs through technology with low environmental impact (in contrast with conventional pyrometallurgical processes, *i.e.*, smelters) is paramount. GDEx is able to operate under mild temperature conditions and using only CO_2 and electrons from a power supply as reagents.

This work studied the feasibility of GDEx to selectively recover PGMs after their leaching from end-of-life products (*i.e.*, automotive catalytic converters). These leachates contain about 27 metals, wherein the PGMs appear relatively diluted (from 20 to 170 mg L^{-1}). The removal efficiency was favored under higher current densities, reaching PGM removals greater than 95%. The nanoparticles directly produced showed a high PGMs content (>90% mass purity). The recovered PGMs could be recycled to be used again in automotive catalytic converters (Nicol et al., 2021); however, they could directly serve as unsupported (electro)catalysts, *i.e.*, for the oxygen evolution reaction (Reier et al., 2012) or methanol oxidation (Zhao et al., 2011).

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