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Electrohydrodynamic methodologies to support hydrometallurgical-based recycling of noble metals

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Abstract:

In recent years, several metals have become critical to industrial manufacturing and electronic device production. Due to the geographic mismatch between resource viability and demand, along with the environmental and social impacts of mining, secondary metal recovery – i.e., extraction from waste – has gained strategic importance. This work is part of the PRIN PNRR project DURABLE, which aims to develop innovative processes for recovering noble metals such as gold and platinum from waste electrical and electronic equipment (WEEE) and spent automotive catalysts (WCat). The process integrates mechanical separation of valuable components with selective hydrometallurgical techniques, primarily leaching and adsorption. The approach targets two main outcomes: the production of waste-derived catalysts (WDC) for the biodiesel industry and secondary materials enriched with target metals. This contribution highlights how electrohydrodynamics enhances the adsorption and refining stages of the process. Two case studies are presented: Pt-WDC film production via electrospray and gold recovery via electrospun fibers. In the first case study, platinum is leached in mild acid-oxidant solutions and adsorbed onto micrometric sorbents, which serve as catalyst supports. The platinum-loaded sorbent is suspended in ethanol and deposited as a thin film by electrospray deposition. This method stabilizes particles, preserves surface area, and improves catalytic performance. In the second case study, gold is extracted from WEEE using mild acid-oxidant solutions, with or without microwave assistance. To recover residual gold from the leachate, functionalized electrospun fibers – derived from chemical agents and biowaste – are used to selectively adsorb residual gold ions with high efficiency. These fibers can be thermally treated to recover the gold. Electrohydrodynamic techniques significantly enhance process efficiency, while keeping low energy demand. These results underscore their potential to support sustainable hydrometallurgical strategies in green urban mining.

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