Green and Sustainable Urban Mining of Noble Metals

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The circular economy of noble metals and rare-earth elements (REE) is a critical point of development for the European Union. This works resumes the main findings of the PRIN PNRR Project Green and Sustainable Urban Mining of Noble Metals (DURABLE), which has the ambition to develop new processes and technologies to recover noble metals, in particular gold (Au), platinum (Pt) and rhodium (Rh) from spent catalysts (WCat) and waste of electric and electronic equipment (WEEE), boosting the sustainability and the circular economy of the noble metal recovery processes.

The mainstream of the process consists of a sequence of selective leaching aimed at obtaining high yields and selective separation of gold, platinum, and rhodium from WCat and selected WEEE components, followed by a refining step based on adsorption, photo-deposition, or electrochemical deposition of the two noble ions over different supports. The overall process is tuned towards two main targets. Adsorption processes are carried out with specifically designed electrospun fibres and/or engineered biowastes to maximise metal selectivity and sorbent loading, to facilitate thermal recovery of the noble metals in the ashes of controlled gasification and pyrolysis processes. The second option aims to select adequate sorbents/supports and tune the operating conditions of adsorption and deposition processes to achieve metal-loaded sorbents that can be used as waste-derived catalysts (WDC) for biorefining, providing new routes for the valorization of glycerol, the main byproduct of biodiesel production.

Experimental and modelling studies on real WEEE and WCat indicate that selective leaching is capable of recovering more than 95% of the target metals, while adsorption and deposition processes allow fine tuning of the nanometric noble metal loading within the entire range of interest for biorefining catalysts. The new sorbents used for thermal recovery allow loading up to 30 g of gold and platinum per 100 g of sorbent used, allowing a remarkable recovery of metals with very low energy duty required for pyrolysis or gasification. XRF analysis indicates that WDCs show not only a remarkable noble metal content but also a high chloride concentration due to the acid treatment in HCl, possibly affecting the catalytic activity. Specific surface area of WDCs is generally lower than that of the fresh sorbent, but large enough to assure a good dispersion of the noble metals.

Keywords: *urban mining, noble metals, leaching, electro-deposition, photo-deposition, adsorption*