

Electrochemical oxidation of copper(I) to make solvometallurgical recovery of PGMs circular

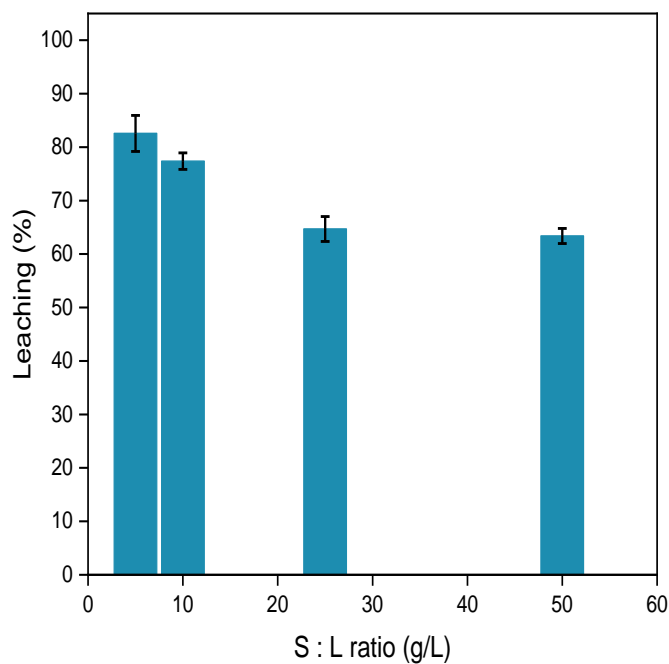
The **FIREFLY** project promotes the sustainable evolution of the catalyst-based chemical industry via **electrification** with the aim of lessen third-party dependence on metals and fossil energy. This concept focuses on the development of:

- Electro-driven technologies based on modelling and optimization of metal recycling from spent, waste, and off-specification catalysts available in Europe
- Incorporation of renewable electricity in these technologies
- A digital tool towards a predictive decision-making
- Manufacturing (electro)catalysts for innovative (electro)chemical processes which would overcome lack of circularity.

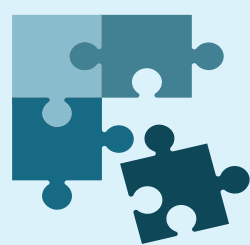
FIREFLY



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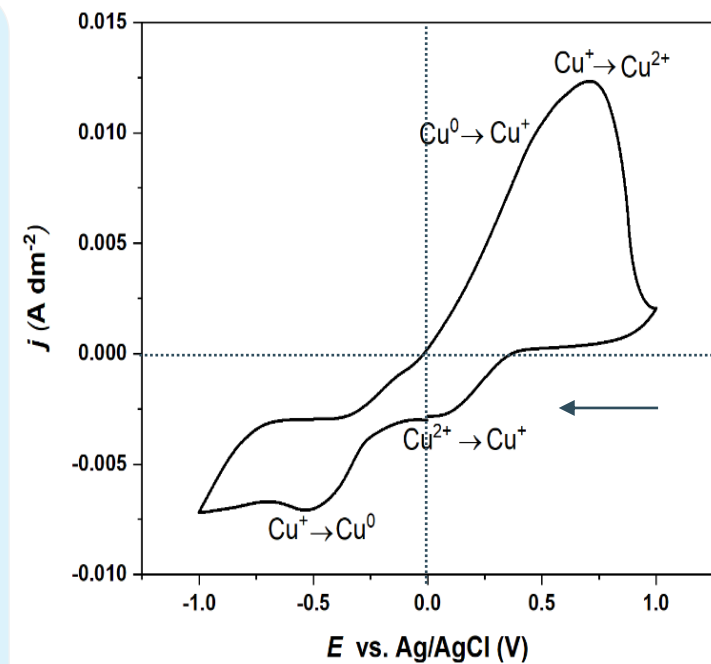


Leaching efficiency of Pd in 1 M CuCl₂ in ethylene glycol, at 70 °C, 700 rpm, 3 hours at various solid to liquid ratios.



Combination of **selective oxidative leaching** and **electro-oxidation of leaching agent** can be applied in non-aqueous media via **solvometallurgical route**

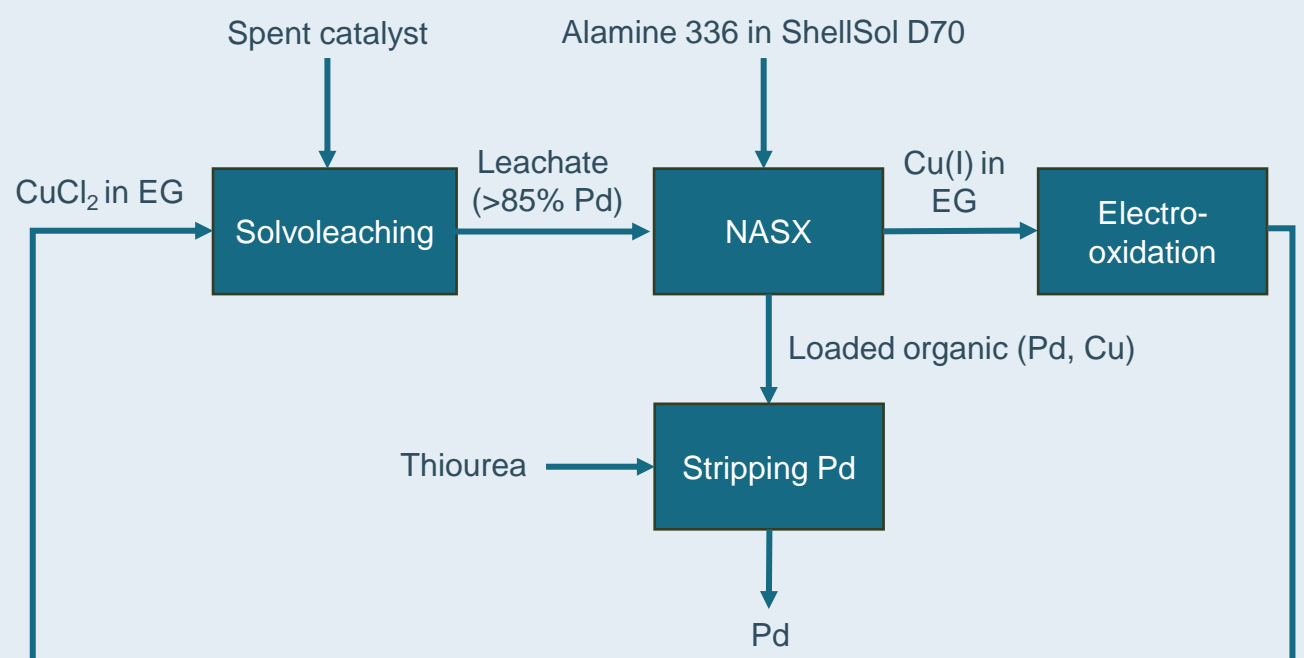
- PGMs can be selectively leached at a temperature of 70 °C and ambient pressure
- Pd can be efficiently extracted using 30 v/v% Alamine 336 in ShellSol D70, at room temperature
- Stripping of >99% Pd can be done with 1 mol/l thiourea solution (O:A 1:1) in single stage
- Electrooxidation of Cu(I) to Cu(II) in ethylene glycol is successful within the electrochemical window



Cyclic voltammogram of 0.01 M CuCl in EG (Scan rate :5 mV/s, WE:GC rod, CE: Pt wire, RE: Ag/AgCl in 3 M KCl)

Proposed flowsheet

- Oxidative leaching is performed using Cu(II) in ethylene glycol, resulting of >85% Pd recovery in single step
- Selective extraction of Pd (97%) from PLS is achieved via optimization of solvent extraction and stripping steps
- Cu(II) can be regenerated via electro-oxidation of Cu(I) to Cu(II) after the leaching step, making the process circular



References

- Binnemans, K.; Jones, P. T. Solvometallurgy: An Emerging Branch of Extractive Metallurgy. *J. Sustain. Metall.* **2017**, *3*, 570–600. <https://doi.org/10.1007/s40831-017-0128-2>.
- Nguyen, V. T.; Riaño, S.; Aktan, E.; Deferm, C.; Fransaer, J.; Binnemans, K. Solvometallurgical Recovery of Platinum Group Metals from Spent Automotive Catalysts. *ACS Sustain. Chem. Eng.* **2021**, *9*, 337–350. <https://doi.org/10.1021/acssuschemeng.0c07355>.
- Binnemans, K.; Jones, P. T. The Twelve Principles of Circular Hydrometallurgy. *J. Sustain. Metall.* **2023**, *9* (1), 1–25. <https://doi.org/10.1007/S40831-022-00636-3>.