



**Solvometallurgical recovery of PGMs**

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# Technology concept and description

KU Leuven has developed **three** different innovative technologies for the recovery of PGMs

## Selective leaching

Leaching with a non-aqueous solution



## Non-aqueous solvent extraction with two immiscible organic phases

Conventional Solvent extraction



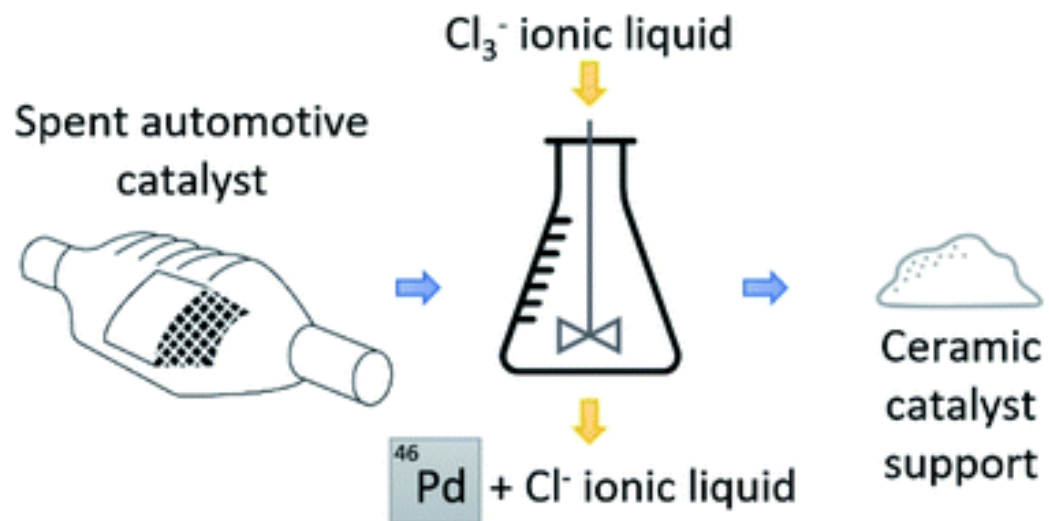
Non-aqueous Solvent extraction



## Key benefits of solvometallurgy

- Different mechanisms of extraction can be exploited, this can be translated into **higher selectivities**
- Can be **environmentally friendly**, depending on the non-aqueous solutions that are used
- Solvents can usually be easily **recovered/recycled**
- **Process intensification**: the number of steps in a process can be reduced because leaching/selective extraction can be combined in one step
- **Individual** metals or **mixtures** of them can be obtained

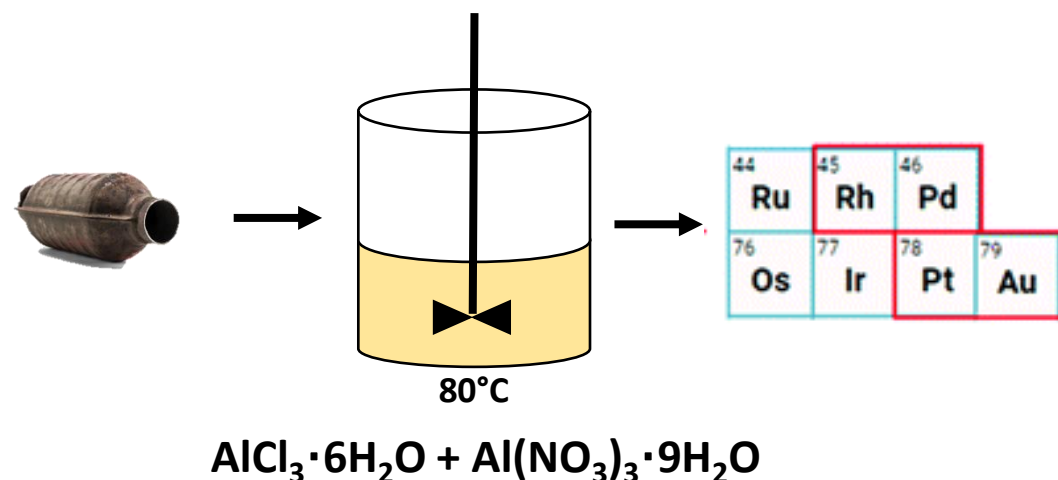
# Dissolution behavior of precious metals and **selective palladium leaching** from spent automotive catalysts by trihalide ionic liquids



- Three trihalide ionic liquids, [P<sub>66614</sub>][Cl<sub>3</sub>], [P<sub>66614</sub>][Br<sub>3</sub>], [P<sub>66614</sub>][I<sub>3</sub>], and one mixed trihalide ionic liquid [P<sub>66614</sub>][IBr<sub>2</sub>] were synthesized
- Leaching with trichloride ionic liquids greatly improved the selectivity for palladium
- Simple process
- Only allows the recovery of Pd
- Environmentally friendly / ionic liquids can be reused

A. Van den Bossche, N. Rodriguez Rodriguez, S. Riano, W. Dehaen, K. Binnemans, *RSC Adv.*, 2021, **11**, 10110-10120

# Dissolution of noble metals in highly concentrated acidic salt solutions



- 95% Pd was leached from spent automotive catalysts in 15 min at 80 °C, while Pt required longer
- Pd recovery was investigated by selective reductive precipitation
- No harsh conditions/chemicals such boiling aqua regia are needed

F. Forte, S. Riaño and K. Binnemans, *Chem. Commun.*, 2020, 56, 8230 (DOI: [10.1039/d0cc02298e](https://doi.org/10.1039/d0cc02298e))

## Noble metals dissolved without aqua regia

BY LUCY BALSHAW | 1 SEPTEMBER 2020



3 COMMENTS

Scientists in Belgium have developed a simple and environmentally-benign method for recovering precious metals from metal wires and spent automotive catalysis. Using highly-concentrated aluminium nitrate and aluminium chloride solutions, they were able to dissolve both gold and platinum group metals, and then precipitate out the pure metals, allowing them to potentially be recycled and reused.

Metals like gold, platinum, and palladium are highly valuable and have applications in the chemical industry, medicine, aerospace and automotive technology, and jewellery. However, these precious metals – also known as noble metals – are not especially abundant and are difficult to purify, meaning that one of the best ways to procure noble metals is by recovering them from end-of-life products, such as catalytic and electronic waste.

A common way of extracting noble metals from other materials is by dissolving that material in solution. However, dissolving noble metals remains a big challenge due to their low reactivity, and effective recycling of noble metals requires high dissolution rates and controllable selectivity.

"Noble metals can be dissolved using different hydrometallurgical methods. Unfortunately, all of them have drawbacks," explains Sethy Chretien, who studies noble metal dissolution on a fundamental level at the Helmholtz Institute Erlangen-Nürnberg for Renewable Energy but was not involved in this research. "The most common approach is to use hydrochloric acid as a complexing agent and nitric acid, chlorine, or hydrogen peroxide as an oxidant."

A mixture of hydrochloric acid and nitric acid is also known as aqua regia, from the Latin for royal water, and is frequently used to dissolve gold and platinum in industry. However, it is a potentially dangerous mixture and there are environmental concerns related to its use. Because of this, there is a significant drive to find alternatives.



Source: © Kees Binnemans, TU Leuven  
Palladium wire is reacted with the mixture until systems mixture after 3 minutes (A), 1 hour (B), 2 hours (C), 3 hours (D), 4 hours (E) and 45 hours (F) leaching.

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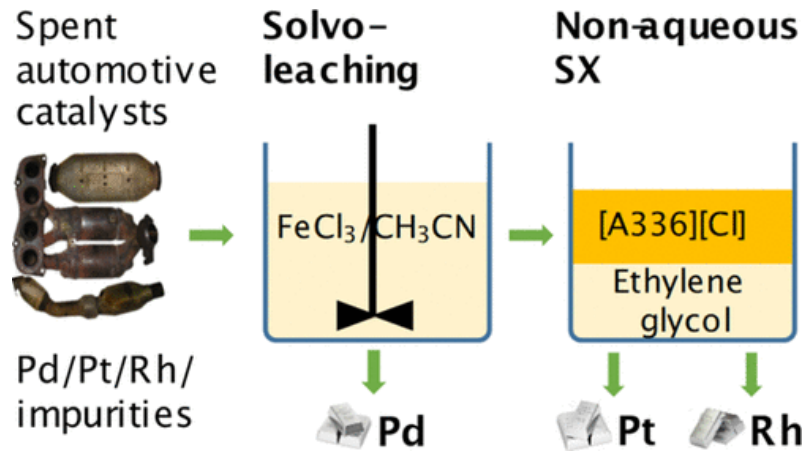


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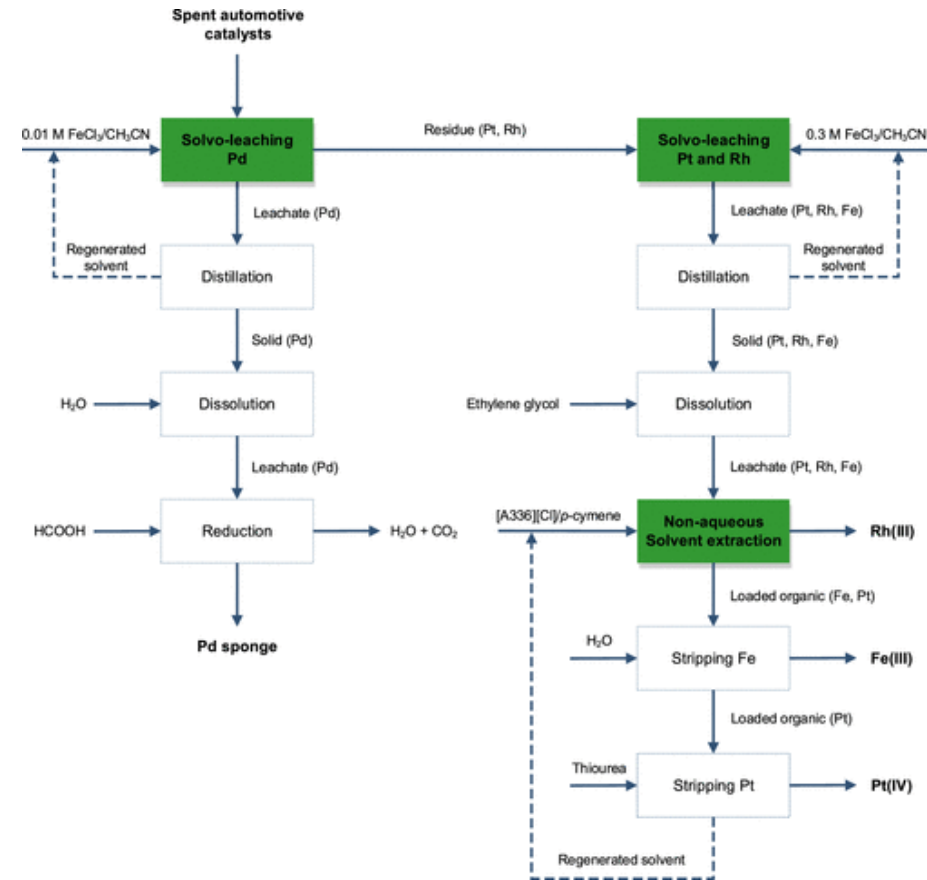
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# Solvometallurgical Recovery of Platinum Group Metals from Spent Automotive Catalysts



- Closed-loop system
- Less hazardous chemicals
- Avoids the emission of toxic or flammable gases while reducing consumption of acids/bases
- Highly selective
- Limits the generation of waste water



V.T. Nguyen, S. Riano, E. Aktan, C. Deferm, J. Fransær, K. Binnemans, *ACS Sustainable Chem. Eng.* 2021, 9, 1, 337–350



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