Europium recycling from e-waste using redox active ligands.

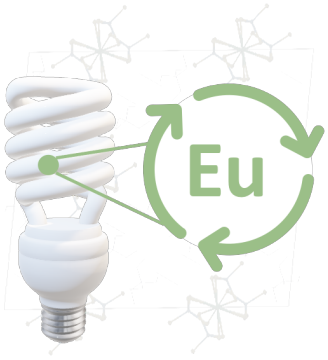
M. A. Perrin[1], V. Mougel[1]*

[1]Department of Chemistry and Applied Biosciences (D-CHAB), ETH Zürich, Vladimir-PrelogWeg 1-5/10, 8093 Zürich, Switzerland

In the current context of energy transition to mitigate climate change, rare earth elements (REE) are key in many technologies, from permanent magnets in wind turbines, batteries in electric vehicles to phosphors in optical displays. As a result of their extensive utilization, their demand is continually increasing and their inequal geographic distribution makes them susceptible to global supply risks, and their recovery is still largely insufficient (<1%). This brings the need for efficient and simple ways of recovering these elements from end-of-life products. Among the REEs, Europium (Eu) is one of the most critical: its scarcity and the high demand to produce red lamp phosphors, have resulted in high market value.[1]

However, separation of the REEs is extremely challenging due to the similar chemical properties of these elements, which all occur in the stable trivalent oxidation state. Separation by traditional methods, such as solvent extraction, are both time-consuming and expensive because many extraction steps are necessary to reach high purity products. Redox chemistry on the other hand proved to be much more efficient to recover europium, since Eu is the REE with the highest reduction potential. This reduction can be conducted with chemical reductants, photochemically or electrochemically, but these methods require additional chemicals, strong UV irradiations or suffer from competitive reactions like hydrogen evolution.[2]

We report the first example of induced internal reduction under ambient conditions of Eu(III) to Eu(II) using redox active thiometallate ligands. This allows a facile separation of europium by precipitation from complex lanthanide mixtures such as end-of-life compact fluorescent lamps.[4-5]



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[1] Peter Fröhlich, Tom Lorenz, Gunther Martin, Beate Brett, Martin Bertau, *Angew. Chem. Int. Ed.* **2017**, *56*, 2544-2580
[2] Nikhil Dhawan, Himanshu Tanvar, Sustain. Mater. Technol. **2022,** *32*
[3] Marie A. Perrin, Victor Mougel, *manuscript in preparation* **2023**
[4] Marie A. Perrin, Victor Mougel, *patent in preparation* **2023**