



ESFC LISBON
21st European
Symposium on
Fluorine Chemistry

<https://21-esfc-lisbon.events.chemistry.pt/>

Perfluorocarbon Emissions During Dysprosium Electrolysis from Fluoride-Based Melts

Vesna S. Cvetković¹, Laras Prasakti², Nataša M. Petrović¹, Bernd Friedrich² and Jovan N. Jovićević¹

(1) University of Belgrade – Institute of Chemistry, Technology and Metallurgy – National Institute of the Republic of Serbia, Njegoševa 12, 11000 Belgrade, Serbia; v.cvetkovic@ihtm.bg.ac.rs

(2) IME Process Metallurgy and Metal Recycling, Institute of RWTH Aachen University, Intzestrass 3, 52056 Aachen, Germany

*e-mail: v.cvetkovic@ihtm.bg.ac.rs

Current environmental policies demand that the entire electrolysis process of greening and cleaning be implemented, from metal extraction to material synthesis. Therefore, there is an urgent need to develop an advanced new green metal extraction process to meet the stringent environmental protection requirements [1]. In general, RE electrolysis generates unnecessarily high emissions of perfluorocarbon gases (PFCs), such as tetrafluoromethane (CF₄) and hexafluoroethane (C₂F₆), which are potent greenhouse gases and are not filtered or destroyed in the off-gas [2]. To address this issue, understanding of the micro-generation mechanism of the greenhouse gases (GHGs) in the Dy electrolysis is crucial in an effort to largely reduce the PFC emission and keep the process in the green process window. To apprehend the mechanism of the greenhouse gas formation CO, CO₂ and perfluorocarbon gases (CF₄ and C₂F₆), in-situ measurements of the chemical identity and amount of the anode gases during electrodeposition of dysprosium metal from fluoride-based melts DyF₃ – LiF = 50 – 50% with 1% Dy₂O₃ were performed.

In the electrolysis process at constant potentiostatic mode which leads to the electrodeposition of Dy metal from fluoride-based melts with a carbon anode and a molybdenum cathode PFC emission is involved as well. However, in the potential range where Dy³⁺ is reduced to Dy metal, the experimentally measured FTIR results from the on-line anode off-gas analysis indicate that the anode gas products mainly consist of CO and CO₂, while negligible amounts of CF₄ were recorded to have been evolved, and C₂F₆ has been detected just above or below the detection limit. The results showed that the CF₄ concentration was not higher than 0.1 ppm in the Dy electrolysis process. Fluorides and oxyfluoride complexes such as [REFx]y- and [REOFx]y- are probably formed during the dissolution of Dy₂O₃ in fluoride-containing melts. The complexes are involved in the reaction with the GC anode, and CO₂/CO and CF₄/C₂F₆ are formed depending on the working potential of the anode [3]. A comparison of the experimental results obtained from Dy₂O₃+DyF₃+LiF electrolyte has shown that the relatively low Dy deposition overpotential prevents fluorocarbon evolution at the anode. The approach presented here to the reduction of the PFC gases emission during RE electrolysis can be considered as an innovative method due to its positive impact on the environment.

Acknowledgements

This research was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia and Deutsche Akademische Austausch Dienst Germany (DAAD; ID: 337-00-19/2023-01/5); V. S. Cvetković and N. M. Petrović acknowledge the financial support received from the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Grant No. 451-03-66/2024-03/200026).

References

- [1] C-Z. Z.; B. M.; S. A.E.; P. D.; F. S. A.; P. R. R. *Metals*, **2024**, *14*, p. 658.
- [2] V. H.; F. B. J. *Nonferrous Metall.*, **2017**, *6*, pp. 27–46.
- [3] V. S. C.; N. M. P.; L. P.; D. F.; S. S. R.; B. F.; J. N. J. *Materials*, **2025**, *18*, p. 184.