

Innovative Low-Temperature Metallization of Dysprosium via Chlorination: Redefining the Economic Viability of Rare Earth Resources

Joo-Won Yu¹, Jei-Pil Wang¹

¹Pukyong National University, Busan, South Korea

Dysprosium (Dy) is a critical heavy rare earth element (HREE) essential for high-performance permanent magnets. Despite its strategic importance, the geographical concentration of mineable deposits and the high operational costs associated with conventional fluorination-based metallization—often involving hazardous reagents and high energy consumption—limit the scalable development of diverse Dy resources. This study introduces a novel low-temperature metallization pathway designed to enhance the process economics of Dy production. The proposed method involves the chlorination of Dy_2O_3 using ammonium chloride (NH_4Cl) followed by a controlled reduction process. A critical aspect of this technology is the suppression of DyOCl intermediates and the precise control of atmospheric oxygen and moisture (below 1 ppm), which enabled a chlorination conversion rate of 99.7%. Results demonstrate that utilizing overstoichiometric ratios of NH_4Cl significantly reduces impurity levels (N, H, and O) in the resulting anhydrous DyCl_3 . By achieving high-efficiency conversion at temperatures substantially lower than traditional smelting methods, this technology offers a practical solution to reduce energy footprints and infrastructure costs. Within the context of "New Technology and Old Deposits," this advancement provides a robust framework for revitalizing historical districts and lower-grade deposits that were previously deemed uneconomical, thereby ensuring a more resilient and sustainable global Dy supply chain.