Electrochemical deposition of Terbium from molten salts

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Introduction

A recent report titled "Critical Materials Strategy" released by the US governmental agencies, described the elements used in clean energy and defense industries that are considered critical in terms of supply risk in the short (0-5 years) and medium (5-15 years) terms [1]. Terbium, along with four other rare earth metals, was deemed critical in this report. With nearly 90% of the global supply of rare earth metals originating from China, it is in the strategic interest of the US to establish a robust recycling and reuse process to address the certain near-future deficiency of terbium [2]. Terbium is a heavy rare earth metal extensively used in clean energy and defense industries. It is a phosphor used in fluorescent lighting. Another important use of terbium is in the magnetostrictive material TerFenol-D, which is an alloy of terbium, iron and dysprosium, which is widely used in defense systems. Previous research work addressing this problem with Terbium has been directed towards investigating its electrochemical and spectroscopic properties [3]. The electrochemical properties of terbium were previously investigated [4], but to the best of our knowledge there has been no quantification of the process prior to this work. This research aims to successfully electrodeposit terbium, and explore the possibility of the application of a simple single-step electrochemical deposition method in real-world scenarios.

Experimental Method

This work focuses on the electrochemical deposition of terbium on different cathodes, from its molten chloride salt in molten LiCl-KCl eutectic. The experiments were conducted in a specially built anaerobic molten salt electrolysis system. The electrochemical set-up consisted of a two electrode system powered by an external power source. The electrodeposition was investigated in the temperature range 400-650^{0}C. Process variables studied include temperature, concentration, deposition potential, current density, and period of deposition. Relationship between various parameters involved in the process and the nature of the deposition was elucidated. Spectroscopic techniques were used for qualitative and quantitative determination of terbium.

Results

Successful electrodeposition of terbium from its molten chloride salt was achieved. EDS and XPS analysis confirmed the electrodeposition. The effect of variables such as cathode material, current density, temperature, concentration of terbium, deposition potential and period of deposition will be discussed.

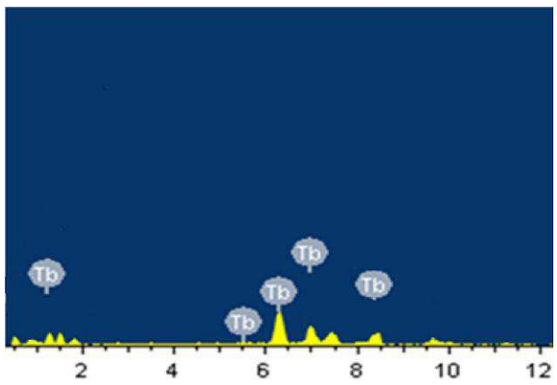

Fig. 1: SEM-EDS analysis of Tungsten cathode after washing in warm DI H_2O for 2.5hrs. Tb deposit was confirmed. The x-axis denotes values in keV.

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References

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