3 - 31 Preparation of Tm and Eu Thin Targets for the Chemical Investigation of Nh

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All isotopes of superheavy elements ($z > 103$) are short-lived and available only at the level of "one-atom-at-a-time" [1]. Experimental research of their chemical properties should be therefore preferentially performed with their lighter homologous elements. Before investigating the chemical properties of Nh ($z = 113$), it is necessary to firstly study Tl ($z = 81$), the homolog of Nh, and Fr ($z = 87$), which is chemically similar to Nh. The suitable short-lived isotopes ^{184}Tl and ^{205}Fr can be produced by bombarding the ^{153}Eu and ^{169}Tm targets with ^{36,40}Ar beam, respectively. We reported here the preparation of Eu and Tm thin targets for the test experiments of Tl and Fr using molecular plating method[2].

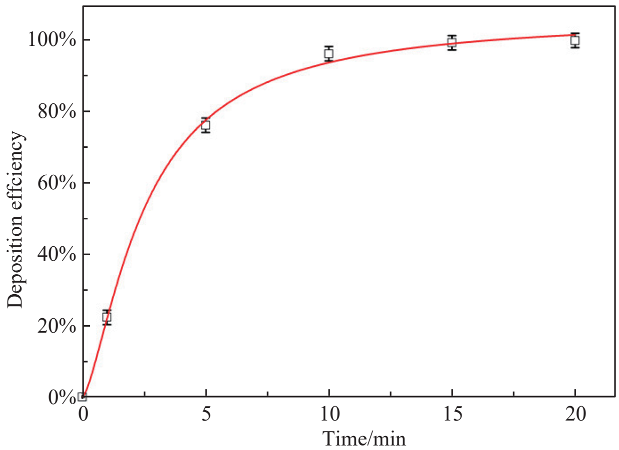

Fig. 1 (color online) The deposition efficiency of Tm targets as a function of the reaction time at 500 V.

The Eu and Tm solutions were prepared by dissolving their oxides powders with natural isotopic abundance in HNO_3 solutions, and the concentrations of Eu and Tm were measured to be (34.161 ± 0.683) g/L and (33.871 ± 0.677) g/L, respectively, with inductively coupled plasma optical emission spectrometry (ICP-OES). One 9-μm-thick aluminum foil was used as the target backing material to optimize the experimental conditions. The molecular plating process was performed in an isopropanol system. A Pt plate was used as the anode, and the Al foil was placed at the cathode. The high voltage was tested from 300 to 600 V, and the plating time was varied from 1 to 20 min to determine the optimal deposition efficiency and target surface situations. From Fig. 1, the deposition efficiency increased rapidly, and the efficiency exceeded 99% after 15 min at 500 V. The target thickness was determined by measuring the concentration of each element in the plating solution before and after the plating process. The surface morphology of the target was analyzed by scanning electron microscopy (SEM).

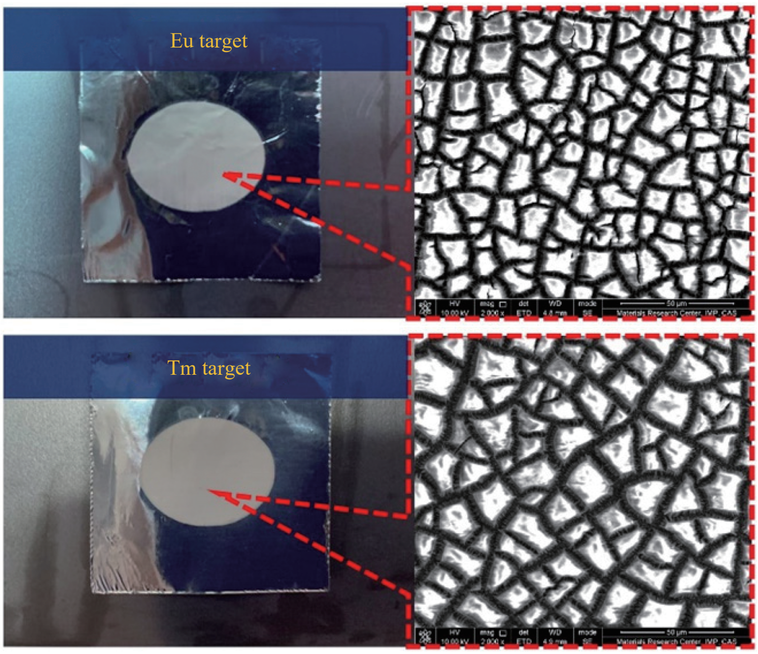

Fig. 2 (color online) Eu (Top one) and Tm (Bottom one) targets as well as the SEM images at a scale of 50 nm.

As a result, fine Eu and Tm targets with the thickness around 500 μg/cm^2 and smooth surfaces were prepared on Al foils by molecular plating method at 500 V for 20 min. Figure 2 showed the photos of Eu and Tm targets as well as the SEM images at the scale of 50 nm. The target surface was smooth and compact with a metallic luster, and no peeling off. The prepared Eu and Tm target will be applied for investigating chemical properties of Nh.

References

[1] A. Türler, V. Pershina, Chem. Review, 113, 2(2013)1237.
[2] L. Zhang, Z. Qin, X. Wu, et al., Nuclear Physics Review, 25, 1(2008)56. (in Chinese)

3 - 32 Application of Deep Eutectic Solvents in the Separation of Rare Earth Elements

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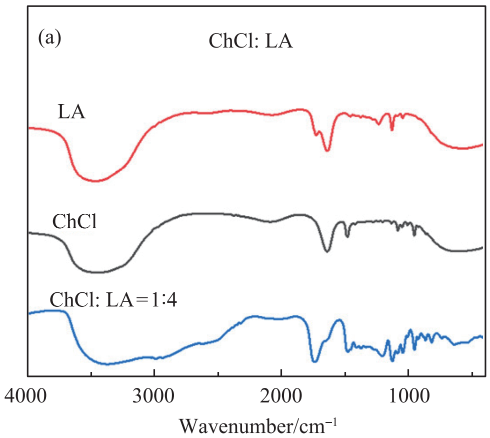
Deep eutectic solvent (DES) is usually a mixture prepared by the complexation of hydrogen bond acceptor (HBAs) and hydrogen bond donor (HBDs) at mild performance temperature. Similar to ionic liquid, DES has unique physicochemical properties such as low steam, strong conductivity, stable electrochemical window and strong design ability. Under a relatively mild condition, DES still shows a strong dissolving ability for a variety of insoluble substances. At present, there have been research on the recovery rare earth element and their oxides.



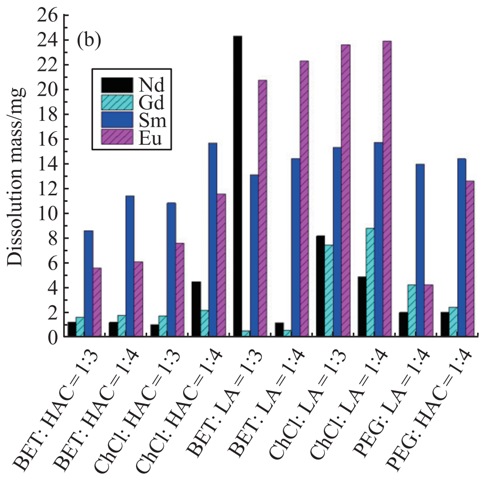


Fig. 1 (color online) (a) Fourier infrared spectrum of DES obtained by mixing choline chloride with lactic acid, (b) DES with strong rare earth dissolving ability.

Here, we prepared a series of deep eutectic solvents and characterized by Fourier infrared spectroscopy (Fig. 1(a)) Very strong hydrogen bond signals were observed, which confirmed the synthesis of DES successfully. At the same time, the strong hydrogen bond signal also affects the further interpretation of Fourier infrared spectra. We further screened the obtained DES and got some solvents with excellent rare earth element solubility, which are often composed of organic acids as hydrogen-bond donor with a quaternary ammonium salt. (Fig. 1(b)) Meanwhile, these DES solvents showed obvious different solubility for light and heavy rare earths, and the solubility gap between light and heavy rare earths can be tens of times. This results can providethe possibility for further separation experiments between the rare earth element or the recovery of the rare earth element from the used nuclear fuel.