Comparison of the electrochemical behavior of some Rare Earth Elements in butyl methylpyrrolidinium dicyanamide ionic liquid

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To evaluate the feasibility of developing an efficient electrochemical separation process for rare earth elements (REE) at room temperature, the electrochemical behavior of some representative REE was evaluated in butyl methylpyrrolidinium dicyanamide (BMPyr-DCA), a room temperature ionic liquid. Because of their chemical properties, their commercial availability and their technological applications, yttrium, lanthanum, neodymium and samarium were selected for this study. The differences in the electrochemical properties of these elements as trivalent salts in BMDCA solutions were evaluated by cyclic voltammetry using a Pt electrode under an Ar atmosphere. For the elements with chemical properties that predict only the reduction in one stage (Y, La and Nd), the results exhibited the simultaneous reduction of BMPyr-DCA and the REE cation and the corresponding oxidation of the reduced REE at anodic potentials that were dependent on the REE cation. For Sm, a two-step reduction process from Sm(III) to Sm(II) and from Sm(II) to Sm(0) was observed, and a clear cathodic peak was observed far from the cathodic electrochemical window limit (-1.38 and -2.25 V vs Fc/Fc⁺); only one anodic peak was observed at -0.93 V, a more negative potential than for the other studied REE. The results show the same behavior as observed in other media (aqueous and molecular media and molten salts) and allow for the evaluation of the possibility of selectively identifying the studied REE in the context of their differing electrochemical responses.

Keywords: dicyanamide ionic liquids, rare earth electrochemical behavior, rare earth element separation process, ionic liquids electrochemistry

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