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Electrical conductivity of multicomponent chloride melts, containing ions of mono-, di-, and trivalent metals

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Melts based on the LiCl-KCl eutectic are becoming attractive in various industrial fields, including nuclear industries. However, their transport characteristics have not yet been sufficiently studied.

The purpose of this work is to study the electrical conductivity of melts similar to those formed during the dissolution of real nitride spent nuclear fuel in (LiCl-KCl)eut., and also to develop a model that would allow us to evaluate the electrical conductivity of multicomponent melts of arbitrary compositions based on the conductivity of 2-3 component mixtures.

To achieve this goal, we measured the electrical conductivity of the molten (LiCl-KCl)eut. mixtures with various mono-, di- and trivalent metal chlorides (CsCl, CdCl2, SrCl2, CeCl3, NdCl3, UCl3) in a wide temperature range. Also, the electrical conductivity of several multicomponent mixtures (LiCl-KCl)eut. - CsCl + MeCl2 + MCl3 with various combinations and concentrations of components was measured. In the present work, a capillary quartz cell with platinum electrodes and the AC-bridge method at the input frequency of 10-75 kHz were used. The density of the melts and their molar electrical conductivity was calculated.

Electrical conductivity is a non-additive property. For example, the conductivity deviations of the (LiCl-KCl)eut. + NdCl3 molten mixture from additive values reach ˜ 80-90%. The stronger the interaction (complexation) between the ions in the melt, the greater the deviations from additivity. Mixtures composed of (LiCl-KCl)eut. and CeCl3, NdCl3, etc., showed such strong interactions. The results were interpreted in terms of the coexistence and mutual influence of the complexes formed by mono-, di-, trivalent cations, and counter anions in these molten mixtures. When UCl3 or LnCl3 are dissolved in the molten LiCl-KCl eutectic the nearest U3+ - Cl- or Ln3+ - Cl- distance is reduced, as well as the coordination number of the trivalent cation. In all cases, coordination number(CN) ≥ 6. This leads to a decrease in the concentration of electricity carriers Li+, K+ and, especially, Cl-, and, thus, to a decrease in the electrical conductivity of the melt, as we observed experimentally.

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