

Electrochemical Properties of the Lithium/Solid Electrolyte Interface

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The paper is related to the area of the development all-solid-phase lithium power source.

Serviceability of such lithium power source to a great extent is determined by the electrochemical properties of the lithium/solid electrolyte interface.

Thus, in the case of the lithium/liquid non-aqueous electrolyte interface, in the system with solid electrolyte the parameters of passivating film on lithium surface, the corrosion processes as the result of chemical interaction between electrolyte and lithium, morphology of lithium deposit during cycling are significant.

At the same time in the systems with a solid electrolyte, the quality of contact between electrode and a solid phase of electrolyte is of particular concern. During cycling the changes of a system volume resulting in the destruction of the contact are possible.

In the work the investigation results of the process of lithium cations transport through solid electrolyte and its subsequent intercalation in aluminium are presented. Working electrode is a semi-cell where solid electrolyte is deposited on aluminium surface by a specially developed vacuum-thermal method [1,2] From the technological point of view, the deposition of the layer of a solid electrolyte on aluminium is simpler as compared to the deposition of the solid electrolyte on lithium. Working electrode – semi-cell was separated from an auxiliary electrode-lithium by the layer of liquid non-aqueous electrolyte. Lithium was used as a reference electrode.

Compact pore-free films of solid electrolyte were from 3 to 8 μm. Electrolyte synthesis was carried out from the compounds of Li, W, B, S, F. Lithium structure is amorphous one and is close to a glass structure.

During the investigations the methods of impedance spectroscopy, galvanostatic cycling, chronoamperometry have been used.

Investigations of the system have shown that in the process of galvanostatic dissolution of lithium, transport of lithium ions through the pore-free structure of glass and its intercalation in aluminium electrode occurs. Lithium intercalation from solid electrolyte in aluminium results in the change of the stationary potential of a semi-cell. (Fig.1)

Impedance measurements have shown that the complex resistance of semi-cell during the initial period of intercalation decreases, and then increases (Fig.2, 3) The equivalent circuit of the Li(Al)/solid electrolyte interface has been proposed

Influence of solid electrolyte composition and cycling conditions on the kinetics of lithium intercalation in aluminium and the utilization coefficient of lithium deposit has been studied. Peculiarities of the process in solid inorganic, solid polymer and liquid non-aqueous electrolytes have been compared. The actual samples of flat lithium power sources with solid electrolyte and semi-cells based on lithium intercalated in aluminium have been tested.

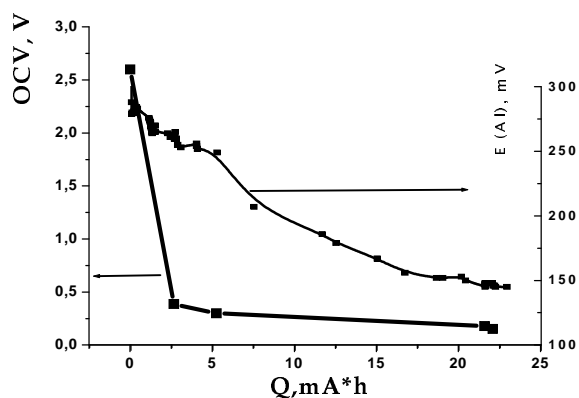


Fig.1. The change of Al-electrode potential at galvanostatic intercalation of lithium, and OCV of the system Al-solid electrolyte based on Li, W, B – oxide, liquid electrolyte-Li

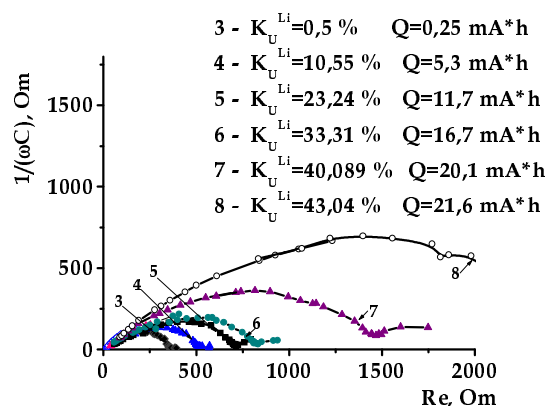


Fig.2. Change of an impedance in semi-cell Li(Al) with solid electrolyte based on Li, W, B – oxide

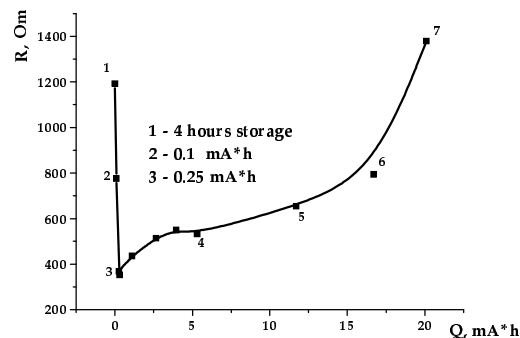


Fig.3. Change of the resistance of the electrode/solid electrolyte interface during galvanostatic process

References

1. E.Shembel, Ye.Kalynushkin, at al. 200th Meeting of The Electrochemical Society, San Francisco, California, USA, September 2-7, 2001.
2. E.Shembel, P.Novak, at al. 200th Meeting of The Electrochemical Society, San Francisco, California, USA, September 2-7, 2001.