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HIGH-RATE SYNTHESIS OF LiPON THIN FILMS BY THERMAL EVAPORATION OF Li_3PO_4 IN A NITROGEN PLASMA*

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Thin films of the LiPON ionic electrolyte are promising for the creation of all-solid-state lithium-ion microbatteries. However, the most common magnetron method of these films deposition has a low productivity. To increase the rate of synthesis of thin LiPON films, we used the method of lithium orthophosphate evaporation in a nitrogen arc plasma. It was shown that anodic evaporation of Li_3PO_4 in high-current arc is accompanied by intense decomposition of Li_3PO_4 vapor, which leads to an increase in the concentration of free lithium atoms both in the arc plasma and in the bulk of the film. The high diffusion mobility of lithium atoms in the film and its interaction with free oxygen atoms that arise when they are replaced by nitrogen in the LiPON structure promote the formation and the rapid growth in the growing film of inclusions with a composition different from that of LiPON. This effect makes it difficult to obtain single-phase LiPON films with a uniform microstructure and degrades the ionic conductivity of the films. A method was proposed for indirect heating of a crucible with Li_3PO_4, which reduces the interaction of the nitrogen arc plasma with dense vapor near the melt surface. The results of measuring the elemental composition of the films and their microstructure are presented. Reducing the degree of vapor decomposition allowed for higher Li_3PO_4 evaporation rate and obtain LiPON films with ionic conductivity up to $2 \cdot 10^{-6}$ S/cm at a film deposition rate of up to 10 nm/min.

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