
Glasses and glass-ceramics for all-solid-state sodium batteries

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Abstract

In many applications, total or partial crystallization of the material plays an important role. Essential in electrical and optical memories in which amorphous and crystalline phases are the operative part "0" and "1" bits respectively, the crystallization becomes an optimization key to improve the mechanical resistance of the material in the case of optical components, or to produce an electrochemically stable material and to improve the ion conductivity in the case of solid electrolytes.

In the field of electrochemical energy storage, research in Na-ion battery technology has grown significantly in recent years as an emerging storage technology for renewable energies such as wind turbines, solar photovoltaic and solar thermal systems. To date, the materials studied for the development of all-solid-state Na-ion batteries are essentially crystalline materials, but glasses and glass-ceramics cannot be ruled out.

In the presentation, our work dealing with the development of an all-solid-state sodium battery operating at high temperature ($T > 200^\circ\text{C}$) based on the use of oxide materials will be first described. The battery is built up using the Spark Plasma Sintering (SPS) method with a sodium boro- or germano-phosphate (NGP) glass as the electrolyte and crystallized $\text{Na}_3\text{V}_2(\text{PO}_4)_3$ (NVP) as the electrode. The different stages of battery assembly as well as the first electrochemical tests will be presented. In the second part of the presentation, the development of all-solid-state batteries operating at lower temperature, ideally ambient temperature, will be discussed. In this case, sulfide glasses or glass-ceramics from the thiogermanate and/or thiosilicate systems, prepared using the ball milling technique, will be considered as the electrolyte materials. In the case of glass-ceramics, the phases which precipitate within the vitreous matrix, in particular the Na+-richest stable and metastable ones, will be identified.

Keywords: Electrolyte, all-solid-state batteries, SPS

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