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Oxide Glass Cathode Materials for Lithium-Ion Batteries Applications

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Rechargeable lithium-ion batteries (LIBs) are a major alternative to reduce our dependence on fossil fuels. LIBs use cathode materials based on polycrystalline oxides or polyanionic compounds. However, some of these materials have limited performances (limited energy and power density and poor cycling life) due to their crystalline structure, while others experience irreversible phase changes during cycling. To address these issues, the use of glasses as cathode materials appears to be a promising approach. It is possible to achieve high specific capacities depending on the composition of the glass [1]. Glasses have a structure with high free volume, which can accommodate a large amount of lithium and easily enable structural changes upon lithium ion extraction/insertion. Additionally, glass production is a scalable process and may be easier to implement commercially than most synthesis processes for conventional cathode materials.

The present study evaluate different oxide glass compositions and operating conditions with the aim of developing high performance cathode materials limiting the use of critical materials such as cobalt. A significant influence of transition metals (Fe and Mn) and polyanions (PO₄, BO₃, and SiO₄) on the microstructural and electrical properties of bulk glasses was observed. Key performance indicators such as specific capacity, irreversible capacity loss on first charge, redox potentials, and coulombic and energy efficiencies were measured in a coin cell.

The relationship between the physicochemical properties of the glass cathode and the electrochemical characterization of the Li-ion cell was systematically investigated. These pioneering findings were thought to be of great interest, paving the way for the future development of glass-based positive electrode materials with high energy densities.

[1] K. Kercher *et al.*, « Mixed polyanion glass cathodes: Glass-state conversion reactions », *J. Electrochem. Soc.*, **vol. 163**, no 2, p. A131-A137, 2016, *doi: 10.1149/2.0381602jes*

Working principle of Li-ion battery with schematic representation of the glass network in positive electrode

