

# Interfacial observation between $\text{Li}_{1.5}\text{Al}_{0.5}\text{Ti}_{1.5}(\text{PO}_4)_3$ and $\text{LiCoPO}_4$ thin films prepared by pulsed laser deposition using SIMS and XPS

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Nowadays, lithium ion batteries (LIBs) with high energy densities and without any safety concerns are necessary especially for portable electronic devices. One promising approach to exclude flammable solvents of the liquid electrolyte are thin film lithium-ion batteries with a solid electrolyte.<sup>[1]</sup> To achieve a high performance of all-solid-state batteries, a suitable electrode-electrolyte interface has to be formed. Interfacial observations between  $\text{LiCoO}_2$  and sulfide electrolytes were already reported, while oxide electrolytes – another promising material class for LIBs – have not been investigated this detailed.<sup>[2]</sup>

In this work, interfacial changes were observed between thin films of lithium aluminum titanium phosphate (LATP) and lithium cobalt phosphate (LCP), both of which were prepared by pulsed laser deposition for the solid electrolyte and high-voltage cathode, respectively. Both materials are well-known bulk materials in lithium ion batteries.<sup>[3,4]</sup> Besides the influence of temperature on the crystallization of the thin films, as evaluated by temperature dependent X-ray diffraction and AFM images, we show the interfacial diffusion behavior of the elements by SIMS depth profiling, which reveals a wide diffusion of the present transition metals. By means of XPS measurements, chemical changes due to the preparation of thin films compared to the bulk materials and due to the interface between LATP and LCP have been analyzed. This study provides a comprehensive analysis of the interface of oxide cathode active materials and oxide solid electrolytes regarding the diffusion behavior and changes within their chemical state.

## References:

- [1] J. Janek, W. G. Zeier, *Nat. Energy* **2016**, *1*, 16141.
- [2] A. Sakuda, A. Hayashi, M. Tatsumisago, *Chem. Mater.* **2010**, *22*, 949.
- [3] H. Morimoto, M. Hirukawa, A. Matsumoto, T. Kurahayshi, N. Ito, S.-i. Tobishima, *Electrochemistry* **2014**, *82*, 870.
- [4] F. Wang, J. Yang, Y. NuLi, J. Wang, *J. Power Sources* **2011**, *196*, 4806.