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Geo-inspired Fluorination of Layered Double Hydroxides: From Synthetic Clay-like Structures to Conversion Cathodes for All-Solid-State Lithium Batteries

Inspired by naturally occurring layered clays and their structural versatility, we explore the potential of synthetic Layered Double Hydroxides (LDHs)—minerals structurally akin to hydrotalcite—as reactive precursors for advanced energy storage materials. By harnessing their lamellar architecture and ability to host multi-metallic compositions, LDHs mimicking mineral analogues were synthesized with Mg, Cu, Al, and Fe cations, and subsequently subjected to solid-gas fluorination using F_2. This geochemically inspired transformation echoes natural processes of mineral alteration, enabling the formation of finely dispersed transition metal fluorides (CuF_2, FeF_3) within a residual matrix of MgF_2. Structural transitions were characterized using XRD, SEM, and XAS, revealing topotactic mechanisms reminiscent of natural fluorination paths. Electrochemical testing in all-solid-state lithium batteries demonstrates that the sample fluorinated at 350°C delivers a high specific capacity (731 $mAh{\cdot}g^{-1}$) and excellent reversibility (76% charge recovery), outperforming conventional binary fluorides. These results underscore the relevance of mineral-inspired architectures in designing functional materials and highlight the broader geoscientific implications of controlled synthetic transformations in layered compounds. Beyond battery research, this study bridges solid-state chemistry and mineralogy, offering new insights into the design of hybrid geo-functional materials.

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Biography

Katia Guérin Araujo da silva is a full professor of the Clermont Auvergne University.

After getting the title of engineer from ENSCPB school, she received her Ph. D in chemical physics at Bordeaux University in 1999. She worked on lithium-ion insertion mechanism into graphite and hard carbons through solid state NMR and Raman spectroscopies.

Her research activities are now focused on solid-gas fluorine chemistry to discover new materials usable mainly in electrochemical energy storage materials in batteries, fuel cells and supercapacitors.

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