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Q: What structural type is more preferable for practical applications?

It depends on the type of application. For portable applications α -NaFeO₂ (derived from the rock-salt type) is preferable because this layered structure provides relatively high specific energy and fast Li-ion diffusion in solid-state and, respectively, high specific power. But safety problem does not allow to use such batteries in vehicles etc. due to low stability of this structure type in the charged state (with low Li concentration).

For electric vehicles and stationary energy storage devices the safety aspect is extremely important, and LiFePO₄ as well as LiMn₂O₄ satisfy this requirement despite of the lower energy density in comparison with that one for LiCoO₂ and its derivatives.

Q: What are the advantages of LiFeSO₄F?

I can suggest to read the original paper of P. Barpanda et al. (Nature Materials 10, 772–779 (2011) where these advantages are described. In summary, triplite modification has a higher potential (3.9V) and practically negligible volume change on charging (0.6%) in comparison with LiFePO₄. However, specific energy is close to that one for LiFePO₄ because of the lower capacity (146 mAh g⁻¹). Probably, Li-ion diffusion should be faster in the fluorosulfate. Moreover, the synthesis of the triplite phase is relatively cost effective, as it does not require temperatures above 350°C and the electrode processing uses standard approaches.

Q: How to synthesize polyanion materials?

There are a lot of different approaches from “simple” solid-state synthesis to hydrothermal and soft chemistry techniques. Cathode material on the base of LiFePO₄ with attractive for applications properties should be obtained as the nanostructured composite with carbon, otherwise capacity at reasonable rate (1 – 5 hours for cycle) would be low. There are a lot of various modifications of soft chemistry and hydrothermal techniques to obtain such composites with a very good performance. Recently, synthesis in ionic liquids at low temperature has been successfully applied to obtain fluorosulfates.