New self-supported anode materials for sodium-ion batteries

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The search for new anode materials with high capacity and good cycling stability is a key goal in sodium-ion batteries (SIBs) technology. Among these, $GeFe_2O_4$ with a conversion alloying mechanism is very promising, but it suffers from poor cycling stability and low electronic conductivity [1]. A successful approach to address these challenges is the production of hybrid structures by embedding active material particles in a carbon matrix to buffer volume changes and enhance electronic conductivity. To this aim, electrospinning is an effective method to achieve homogeneous dispersion of active materials in a flexible carbon matrix, producing fibrous mats with high conductivity and good mechanical properties [2].

In this study, electrospinning was used to fabricate pure and Sn or Mg-doped $GeFe_2O_4$@C nanoporous composites as free-standing electrodes for SIBs. XRD analysis showed for both pure and doped GFO only the main peak of spinel phase, while the others can be covered by the huge amount of carbon in the samples. Morphological analysis revealed the carbon nanofiber networks encapsulating spherical GFO particle aggregates. Electrochemical tests showed that GFO nanocomposites had high initial discharge capacities (541-395 mAh/g) that decreased in subsequent cycles (280-156 mAh/g), however outperforming PAN. GFO-Sn@C exhibited superior capacity at all C-rates due to the Sn alloying reaction with Na^+. as well as during long-term cycling tests. In fact, after 50 cycles, GFO-Sn@C showed the highest capacity (260 mAh/g, the pure sample 215 mAh/g) and excellent stability, retaining 176 mAh/g over 250 cycles at C/2 (the pure sample instead reatained 170 mAh/g for only 150 cycles).