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$ZnFe_2O_4$/C NANOPARTICLES BY LASER PYROLYSIS: NEW ANODE MATERIAL FOR LITHIUM-ION BATTERIES

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With the depletion of fossil fuels and the growing environmental concerns, lithium-ion batteries received considerable attention to contribute to the development of electric vehicles and storage for renewable energies. However, existing lithium-ion batteries cannot reach sufficient energy density to address the needs for such applications. One of the issues limiting the energy density is the low specific capacity of the graphite anode (372 mAh/g). Mixed-transition metal oxides with a spinel structure (AB_2O_4 – A, B transition metals) appear as a promising solution to replace graphite with a higher theoretical capacity (between 750 and 1000 mAh/g). Among various oxides, $ZnFe_2O_4$ is an interesting substitute for graphite, as an abundant, cheap, non-toxic and environmental-friendly material with a high theoretical capacity (1000 mAh/g). The nanostructuration of this material as well as a carbon coating around the particles can also help to maintain a mechanical stability during cycling and enhance the lithium kinetics.
$ZnFe_2O_4$/C nanoparticles presented in this work were synthesized by laser pyrolysis. In this vapor-phase process, a CO_2 laser is used to thermally decompose the precursors and synthesize nanoparticles. A solution containing $ZnCl_2$ and $FeCl_3.6H_2O$ dissolved in ethanol in a stoichiometric ratio was used for the synthesis of $ZnFe_2O_4$/C nanoparticles. Ethylene was chosen as absorbent of the CO_2 laser to allow the precursors decomposition and air as the carrier gas. To vary the carbon content of the as-synthesized nanopowders, annealings under air atmosphere were realized (fig.1).

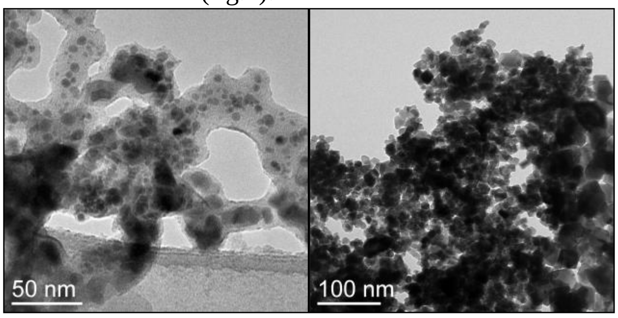

Figure 1. Particles morphology before annealing (left) and after annealing (right)

Electrodes were then prepared using $ZnFe_2O_4$/C (70% wt.), CMC (12% wt.) and carbon additives (VGCF 9% wt., carbon black 9% wt.) to be cycled vs. lithium metal and post-mortem SEM was done to observe the electrodes morphology after cycling.