ABSTRACT

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High-capacity Si-based nanocomposite anodes for Li-ion batteries.

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The massive development of Li-ion technology has fostered the spread of electrical vehicles (EV) with higher driving range. However, the ever-increasing demand in energy density requests for a breakthrough in Li-storage materials. High-capacity anode materials, alternative to the commonly used graphite, have been investigated for several years. Among these, Si plays a special role because of its extremely high theoretical capacity (up to 4200 mAh g^{-1}), which is however associated by sever volume changes (up to 300%) due to Li alloying/dealloying processes, representing a severe limitation to the electrode and cell reversibility and durability.

In this context, the electrochemical behaviour of several nanocomposite materials, based on commercial Si powder of about 100 nm size in which the volume changes are buffered by organic or inorganic matrixes, such as graphene or transition metal oxides, is here presented. The electrodes and cells performances, in terms of specific capacity and durability, are enhanced by optimized electrode and electrolyte formulations, at the same time paying attention to cost and sustainability. A rationale of the improved behaviour is explored by applying several morphological, structural and electrochemical investigation techniques, with a special focus on electrode/electrolyte interfacial properties.