Highly reversible anode for LIB and NIB based on oxidized $Ti_3Al_{(1-x)}Sn_xC_2$ MAX phases

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To improve electrochemical performance of Li-ion (LIB) and Na-ion (NIB) batteries, conversion/alloying mechanisms are a powerful option to store alkaline ions. Unfortunately, these processes induce in active materials (e.g.: oxides, pure metals) low mechanical stability and, consequently, a very short lifespan of the final devices. A way to overcome these main drawbacks is the nano-structuring of the materials used in the electrodes. We have tested a new approach to sinter nanocomposites based on the self-formation of nano $(Ti/Sn)O_2$ system by means the partial oxidation of the $Ti_3Al_{(1-x)}Sn_xO_2$ MAX phase. Exploiting this strategy, we develop composite electrodes of $(Ti/Sn)O_2$ and MAX phase that tested in half-cells vs Li/Li^+ are capable of withstanding over 600 cycles in half cells with charge efficiencies higher than 99.5% and specific capacities comparable to those of graphite and higher than lithium titanate ($Li_4Ti_5O_{12}$) or MXenes electrodes. The main experimental parameters have been deeply investigated in other to maximize the electrochemical performances and understand the mechanisms that favorite their improve. In this case, crucial is the role of the unreacted MAX phase on which nucleated the particles of nano-Ti/Sn oxide: it acts both as a conductive agent and as a buffer to preserve the mechanical integrity of the oxide during the lithiation and de-lithiation cycles. Preliminary results about the use of the same nano-composites as anode for NIB batteries will be also reported and commented.

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