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Study of the Chemical, morphological and structural characteristics of Na-preconditioned Si anodes for lithium ion batteries by synchrotron techniques

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Abstract

The current social challenges in energy storage have led to an increase in research to find new materials with improved characteristics to be used as anode in Li-ion batteries (LIBs) [1,2]. Silicon (Si) is one of the best candidates because of its high theoretical gravimetric capacity of 4200 mAhg-1, about ten times higher than that of graphite (372 mAhg-1). In addition, it is also the second most abundant material in the earth's crust, it is environmentally friendly and has a low electrochemical potential [3]. However, these benefits are accompanied by some drawbacks: (i) the insertion/extraction of Li+ from Si causes a large volume change (> 300%); (ii) after a few cycles, Si may fracture (due to volume expansion) and pulverizes, causing loss of electric contact, which subsequently leads to severe capacity fade. To overcome these drawbacks and improve the stability of Si anodes, the use of nano- and micro-structured Si works. It has also been shown that cycling very slowly (10+ hours) for a few cycles (preconditioning process) before the normal use of the Si anode in a LIB helps to maintain mechanical stability [4,5]. In this work, an electrochemical preconditioning treatment was carried in Si anodes with Na. To observe in greater detail the modifications caused in the Si anodes due to the Na preconditioning treatment, synchrotron X-ray characterizations were used. The morphology of preconditioned Si particles was observed with ptychography. On the other hand, the different Si-Na phases formed during preconditioning, were evidenced through XRD (in situ and operando). Additionally, NEXAFS analysis provided information of the SEI formed on the Si anode.

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