Abstract

The ever-increasing production of portable devices and electric cars asks to the market to produce efficient devices that can store electrical energy. For these types of technologies, where device miniaturization is essential, lithium-ion batteries (LIBs) have become leaders as energy storage systems. The research on the lithium-ion batteries is focused to obtain more performing devices with high gravimetric and volumetric capacities of the electrode materials. In addition to the technological aspect, related to the optimization of materials, there is the supply chain of active components of the battery to consider, starting from lithium. At the moment, the problem is tackled by studying batteries with other alkaline metal ions, i.e. Na^+. However, there are no standardized active materials for these devices, especially on sodium-ion batteries (NIBs), started only a few years later than that of LIBs; therefore, today these technologies are intended to support the LIBs in order to satisfy the enormous market demand of the batteries for the future vehicles. The goal of last years was to develop MXene-based anode materials to obtain efficient anodes for sodium and lithium ion batteries. MXenes are a family of inorganic transition metal carbides, nitrides, and carbonitrides with a 2D structure that would seem promising for the intercalation of different ions due to a great flexibility and adaptability towards several intercalating ions. The ion intercalations occur by a pseudocapacitive mechanism whereby the materials have limited capacity, but they have great electrochemical stability over thousands of cycles and coulombic efficiencies near to 100%. The production of this material was done by HF etching of a precursor called MAX phase. This is the easiest and fastest method to obtain the material in laboratory scale, but it has many criticalities when the process must be scale-up to industrial scale. A large part of this work was spent studying the synthetic technique to obtain MXenes for SIB by reducing or replacing HF in the chemical synthesis. The materials have been characterized by various techniques such as X-ray diffractometry, electron microscopy, X-ray photoelectron spectroscopy, etc., and by electrochemical tests, such as cyclic voltammetry and galvanostatic cycling. Thanks to the 2D structure, a common use of MXene in the literature is in nanocomposite syntheses for NIBs and LIBs, in order to produce high-capacity materials, as required in the battery market. Therefore, two nanocomposites based on antimony-MXene and tin oxide-MXene tested for NIB and for LIB respectively, were synthesized. Both have high theoretical capacity when used as anodes in batteries, however, they are extremely fragile and tend to pulverize during charging and discharging processes. MXene is used as a buffer to limit or prevent cracking and separation of alloys from the electrode surface.