Few-layer Sb_2Te_3 nanoflakes and their Graphene Composite as Anode material for Sodium-Ion Batteries

Ashish Raj, K. P. Lakshmi, T. V. Vineesh, and M. M. Shaijumon
School of Physics, Indian Institute of Science Education and Research Thiruvananthapuram, Maruthamala PO, Thiruvananthapuram, Kerala, 695551, India
E-mail: shaiju@iisertvm.ac.in

Sodium ion batteries are being considered as potential alternative for lithium ion batteries, due to its abundance and similar electrochemical properties to that of lithium. Hence there is huge interest in the development of efficient electrodes and electrolyte components for Na-ion batteries.[1] Among several anode materials explored, antimony based compounds have been of great interest, owing to their higher capacity. However, the performance has been limited in terms of their poor cyclic stability at higher current rates. Nanostructuring and alloying with other elements have been shown to improve the electrochemical performance.[2] More interestingly, there has been continued interest in layered nanomaterials, owing to their improved kinetics and rate performance. Herein, we synthesized few-layer Sb_2Te_3 nanoflakes and their composite with reduced graphene oxide (rGO) *via* facile solvothermal approach.[3] Further, we employ electrochemical exfoliation route [4] to prepare few-layer nanoflakes with reduced lateral dimensions. As-synthesized materials show highly crystalline quintuple layered structure, which is confirmed using various spectroscopic and microscopic techniques. Scanning electron microscopy (SEM) images showed the bulk particles with multiple hexagonal plates stacked to each other in the range of few micrometres and hundreds of nanometres in length and thickness respectively. We study the electrochemical properties of pristine Sb_2Te_3 nanoflakes and their graphene composites by using cyclic voltammograms and galvanostatic charge-discharge measurements in half-cell configuration with sodium metal. The pristine Sb_2Te_3 electrode showed a stable specific capacity of 80 $mAhg^{-1}$ even after 100 cycles with initial discharge capacity of 486 $mAhg^{-1}$ at higher current density of 50 mA g^{-1}. The pristine Sb_2Te_3 electrode suffers from poor electronic conductivity and huge volume expansion, leading to poor electrochemical performance. These issues have been effectively addressed by cycling Sb_2Te_3/rGO composite electrode *vs.* sodium under similar conditions. The Sb_2Te_3/rGO electrode showed an improved stable specific capacity of 124 mAh g^{-1} even after 50 cycles with initial discharge capacity of 507 mAh g^{-1}. Further, much improved rate capability and cyclic stability at higher current rates are exhibited by the composite electrode and thus show potential as efficient layered electrode material for Na-ion batteries.

References

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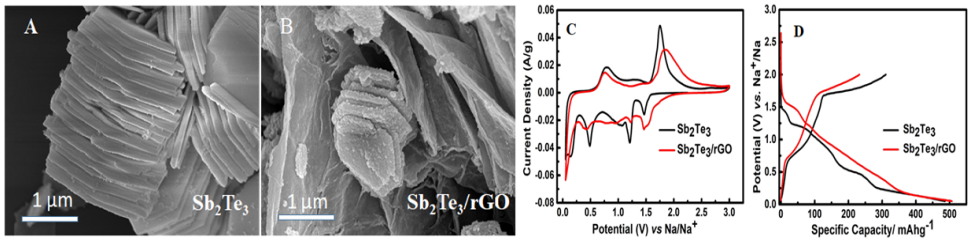

Figure 1. Microscopic and electrochemical characterization of the as-synthesized Sb_2Te_3 nanoflakes and Sb_2Te_3/rGO composite.