National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Nanostructured Si-C hybrid anodes for anode application in lithium- ion batteries
Speaker	: Smita Sowmya Bishoyi (Rollno : 517cr1004)
Supervisor	: Prof. Shantanu Kumar Behera
Venue	: Seminar Hall, CR
Date and Time	: 13 Aug 2024 (11:00 AM)
Abstract	: Si is a promising anode material for lithium-ion batteries. However, its extensive volume dilatation over 300% upon lithiation limits its practical implementation. In this work, we present nanostructured Si-C hybrids synthesized from carbon rich preceramic polymer and milled Si particles and evaluate the phase, microstructure, and electrochemical performance. First, we demonstrate that the use of SiCO derived carbon as a mechanical mixture with Si improves the cyclic stability and rate capability of the composite. Subsequently, Si-C nanostructures have been developed from a preceramic polymer and Si nanoparticles with SiO_2 as a pore former. The composites delivered capacity of 622 mAh g^{-1} for the 400^{th} cycle at 0.1 A g^{-1} current density and 229 mAh g^{-1} at 2 A g^{-1}. Further, we present a hybrid Si-C composite synthesized from a preceramic polymer and Si with the introduction of a surfactant and different process parameters. One of the composites exhibited the maximum stable capacity of 1048 mAh g^{-1} after 200^{th} cycle at a current density of 0.1 A g^{-1} and excellent rate capabilities with 840 mAh g^{-1} at 2 A g^{-1}. Additionally, the composites showed excellent coefficients of Li diffusion, two of the samples with the order of 10^{-14} cm^2 s^{-1}. This work provides a newer approach to prepare porous Si- C hybrid structure utilizing SiCO derived carbon, offering a simple and inexpensive method with superior electrochemical performance. All Si-C hybrids discussed in this work demonstrated exceptional electrochemical behaviour, with the hybrids prepared by adding an interfacial linking agent showing the best results. The elasticity of the SiCO-derived carbon matrix plays a crucial role as a mechanical buffer, accommodating the expansion of Si and acts as a conduit for efficient electron transfer, enhancing the overall performance of the system. The high mesopore surface area and ordered carbon structure in the nanostructured Si-C hybrids led to a positive effect on the electrochemical results which make way for a series of such hybrids with different precursor polymers for application in lithium-ion battery anodes.