National Institute of Technology Rourkela

Progress Seminar

Seminar Title	: Preparation and Characterization of Na3Zr2Si2PO12 (NZSP) Based Electrolyte for Solid State Sodium-Ion Batteries
Speaker	: Ayushi (Rollno : 521cr1001)
Supervisor	: Prof. Ranabrata Mazumder
Venue	: Seminar Room Department of Ceramic Engineering
Date and Time	: 13 Dec 2024 (10:30 AM)
Abstract	: **ABSTRACT**

Sodium ion batteries have good electrochemical performance, wide range of operating temperature, fast charging, do not have over discharge characteristic and are based on highly earth abundant materials, which can replace Li ion batteries. But the liquid electrolytes in sodium ion batteries that are electrochemically unstable have low ion selectivity and can cause leakage. Solid-state electrolyte in solid state Na-ion batteries is an alternative for liquid electrolytes due to long life cycle, simple assembly and thermal stability. However, inorganic solid electrolytes have some drawbacks of low chemical stability, interfacial compatibility, barrier to transfer of sodium ions and process of fabrication. However, NASICON-type electrolyte, $Na_3Zr_2Si_2PO_{12}$ (NZSP) is promising as solid electrolytes as it has high thermal stability, wide potential window, fast conduction of ions, high chemical stability, low thermal expansion coefficient, high ionic conductivity, mechanical stability and compatibility between solid-solid interfaces. Furthermore, NZSP has some drawbacks, like high phase formation temperature and time and difficulties to produce phase pure materials, generally consisting of secondary phases of ZrO_2 and $Na_2ZrSi_4O_{11}$. ZrO_2 secondary phases arises mainly from volatilization of Na due to high sintering temperature .

In this work, we aim to synthesize NZSP using excess Na as precursor (5wt %, 10wt %, 15wt%, and 20wt%) by solution combustion method, to prevent Na loss and form phase pure NZSP at reduced sintering temperature, with high ionic conductivity. The formation mechanism, phase evolution, microstructure, density, electrical conductivity, and ionic conductivity were investigated using XRD, FESEM, and impedance spectroscopy. The XRD result showed phase pure NZSP was obtained for 20NZSP sintered at 1150ºC/6h with dense microstructure and relative density of 94%. 20NZSP showed highest total ionic conductivity of 1.41×10^{-4} S/cm and electrode polarization contributed by the increase of Na^+ carriers and excess Na ion vacancies. The results authenticate excess Na can be effective to remove the ZrO_2 phases, reduce the sintering temperature and obtain high ionic conductivity for improved performance of NZSP SE for energy storage application.