Abstract

Amorphous materials are a subject of wide interest for more than a century due to their diverse applications viz., electro-photography, memory and switching devices, energy storage and other battery applications. Thesis entitled "**Silica Gel Based Li^+ ion Solid Electrolytes: Studies on Structure, Electrical transport and Supercapacitance**" deals with preparations of some amorphous systems prepared by different preparative routes and their application studies. These amorphous systems have been explored for their solid-state properties in terms of their structure, composition, preparative routes and for their advance applications in energy storage devices.

Present thesis has been divided into six chapters and these chapters describe the preparation procedures and properties of amorphous systems prepared through conventional methods and silica gel-based systems prepared through sol-gel process. Chapter 1 contains the brief literature overview to understand the structural model of the glasses, glass transition behavior and their ionic conduction. This chapter also reviews the literature findings on spectroscopic investigations of sol-gel derived different silica-gel or silica glass systems and their properties. Chapter 2 describes the details of materials, methodologies, characterization tools and software used in the research work to explore the properties of the prepared glass composites. The concepts of characterization and analysis using powder X-ray diffraction (pXRD), EPR, FT-IR, XPS, thermal analytical techniques (TGA, DSC, and DTA) has been discussed briefly. Chapter 3 specifics about the conventionally processed lead oxyhalide glasses. These glasses have the added components of cadmium oxides or halides. Their structure and property correlations have been explored via thermal characterization. Chapter 4 briefs about the sol-gel processed silica gel solid electrolytes. These silica gel composites have been confined with different ionic liquids (ILs). IL explored in the present work are viz., [Bmim] Br (1-butyl-3-methylimidazolium bromide), [EMIM] BF_4 (1-Ethyl-3-methylimidazolium tetrafluoroborate) and [EMIM] CF_3SO_3 (1-Ethyl-3-methylimidazolium trifluoromethanesulphonate). Their influence on structure and electrical properties of lithium nitrate confined silica gel electrolytes has been correlated and explored thoroughly. The highest ionic conductivity (4.9×10^{-4} $\Omega^{-1}cm^{-1}$ at room temperature) has been observed for a composite confining ionic liquid [EMIM] CF_3SO_3

and 46 mol% of lithium ions. Chapter 5 details about the potential application of sol-gel derived silica gel solid electrolytes as supercapacitors. Preliminary investigations on device applications of these composites suggest that a proper tuning of the composites can lead to an innovative achievement in energy storage solid state devices. The composite which showed the highest ionic conductivity also showed the highest capacitance value (28 Fg^{-1} at room temperature). Chapter 6 summarizes the conclusions of the overall thesis and suggests future scope of the research work.