Notification No. : 518/2022

Date of Notification :02-08-2022

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Topic of Research : A Study of Physical Parameters of Nanoscale Modified Chalcogenide Glasses

Research Findings

Chalcogenide glasses (ChGs) are technologically important class of functional materials composed of at least one chalcogen element (sulfur, selenium, or tellurium) alloyed with other element (or combination of elements) such as Ge, As, Sb, Ga etc. to form stable glasses. In the present thesis, solution processing has been adopted as the method for the modification of ChGs at nanoscale. Solution-based processing of ChG films is a rapidly evolving process due to ease of synthesis, suitability for flexible applications and scope for scalability. Stoichiometry of ChGs is also conserved in this method. This method also provides an opportunity for an easy integration of functional nanomaterials in the ChG matrix. The nanoscale modification of ChGs was performed by two approaches: (i) Incorporation of functional nanomaterial in ChG matrix, (ii) Optimization of synthesis parameters to achieve nanoscale morphology of ChGs.

First segment of this work was incorporation of multiwalled Carbon nanotubes (MWCNTs) in As_2S_3ChG films using solution processing. This study gave remarkable enhancement in dc conductivity (order of $10^4\ \Omega^{-1}cm^{-1}$) and free charge carrier concentration (order of 10^3 per cm^3) of the ChG films. These films may find their use in different applications such as photovoltaics, energy storage, energy harvesting etc.

In another study, $Ge_{10}As_{40}Se_{50}$-PVA nanocomposites free standing films were synthesized with varying concentration of ChG nanoparticles.These nanocomposites exhibited shift of photosensitivity from UV to IR region of the electromagnetic spectrum on increasing the concentration of $Ge_{10}As_{40}Se_{50}$ChGnanoparticles in nanocomposites, thereby decreasing the optical bandgap of the nanocomposites. These naocomposites may find their applications in optical storage, optical sensing etc.

In the subsequent study, an extensive work was done on the optimization of synthesis protocol for the morphologically controlled synthesis of solution processed $Ge_{23}Sb_7S_{70}$ChGnanoparticles films. Ultrasmall $Ge_{23}Sb_7S_{70}$ nanoparticles were formed, whose size were observed to increase with increase in the concentration of the ChG. The optical bandgap and refractive indices of the films were observed to decrease and increase respectively with increase in concentration of the ChG in films. It is suggested that the insights from this study can be used to synthesize IR optical components such as nanolenses, complex microlenses, and nanoresonators.