ABSTRACT

"Thermoelectric Characterization Of Functionalized Poly(3,4-ethylenedioxythiophene) And Its Nanocomposites For Device Applications"

Submitted by

Shilpa Maity

Index no.: 17/21/Phys./27

The breakthrough invention of conducting polymers (CPs) initiates a new pathway for the researchers to make use of their properties in thermoelectric (TE) applications. They are potential candidates in TE application when combined with inorganic counterparts. Therefore, investigation on the properties and synthesis of hybrid TE materials of conducting polymer and different nanofillers is very important. The present work mainly focused on the synthesis of conducting polymer Poly(3,4ethylenedioxythiophene) (PEDOT) and its hybrid composite along with the study of its structural and electrical properties for TE applications.

In-situ polymerization technique has been employed for the synthesis of PEDOT from its monomer (EDOT) for TE property analysis. The reaction condition and variation of nanofillers in the polymer have been investigated. It is observed that different nanofillers influence the morphology of the material which in turn stimulates the TE properties of the material. Further, the effects of different oxidizing agents on the TE performance of the materials are also noteworthy. It has been observed that in hybrid composite of tosylate doped PEDOT and SWCNT, with the variation of SWCNT content, there is an increase in the ordered structure, resulting an enhanced electrical conductivity. This is attributed to the increases in the carrier concentration by pushing the Fermi level (E_F) into the conduction

band. Though the thermoelectric power decreases, yet there is an overall increase in power factor that leads to an increment of ZT. On the other hand, in tosylate doped PEDOT/Graphene hybrid composite a simultaneous hike in room temperature electrical conductivity and thermoelectric power is noted with the increasing graphene content. The increase is due to the increase in the degree of ordered structure enhancing the hopping rate (including hopping distance and activation energy) within the polymer matrix in addition to the increase in the charge carrier mobility. At the same time low thermal conductivity due to the large phonon scattering by the introduction of nanointerfaces increases the figure of merit ZT.

Selenium (Se) was also used to functionalize PEDOT, and the structural and electrical transport characteristics of functionalized PEDOT with Se were examined. The addition of Se to the PEDOT matrix indicates an improvement in the structural order thereby enhancing the thermoelectric characteristics. We suggest that the creation of connected chains of PEDOT containing Se recuperate the figure of merit by boosting electrical transport but impeding heat transport. Hence the present work reports that PEDOT polymer and its hybrid composites are so distinctive that they are well thought out to be extremely capable and hopeful TE candidates. Further ease of synthesis and mechanical flexibility of those materials permits various design to be used in device applications. The inimitability of these materials undoubtedly opens a new era of smart materials with the initiation of opportunities in TE domain.

Sukhen Das 16/08/2023

Prof. Sukhen Das
Department of Physics,
Jadavpur University
Kolkata - 700 032

Shilpa Maity
16/08/2023

Krishanu Chatterjee 16/08/2023

Dr. Krishanu Chatterjee
Associate Professor
Department of Physics,
Techno India University, West Bengal
Kolkata - 700091