Investigation and Optimization of Thermoelectric Properties of Hydrochloric Acid Doped Polyaniline

W.G.T.L. Weerasinghe[1]*, P. Samarasekara[1,2], T.M.W.J, Bandara[1,2], L.K. Narangammana[1,2]

[1] Department of Physics, University of Peradeniya, Sri Lanka
[2] Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka
**thilinaweerasingheure@gmail.com*

Global warming and the depletion of fossil fuels have driven the demand for novel energy conversion technologies. Thermoelectricity is a phenomenon that can convert waste heat into electricity. A thermoelectric module is an array of two dissimilar (p-type material and an n-type material) thermoelectric materials (TEMs), arranged electrically in series and thermally in parallel. Since conventional TEMs like Bi_2Te_3 and Sb_2Te_3 are toxic and rare, there exists a high demand for non-toxic TEMs. The p-type organic semiconductor/conductive polymer: polyaniline (PANI), has been widely used in thermoelectric power generation due to its low cost, non-toxicity and easily tunable thermoelectric properties through doping. An attempt has been made to optimize the thermoelectric properties of PANI through doping with hydrochloric acid (HCl). The chemical oxidative polymerization method was used to synthesize HCl doped PANI (HCl-PANI). The synthesized powder was pressed into pellets to measure the electrical conductivity at room temperature and temperature dependent Seebeck coefficient for 8 different HCl concentrations, 1.0 M, 1.25 M, 1.5 M, 1.75 M, 2.0 M, 2.5 M, 3.0 M and 4.0 M. The successful synthesis of HCl-PANI was confirmed by Fourier Transform Infrared Spectroscopy (FTIR). Characteristic peaks (1364, 1217, and 1088 cm^{-1}) were consistent with PANI. Thermogravimetric Analysis (TGA) revealed that HCl-PANI is stable in the temperature range from room temperature to 350 °C. The highest electrical conductivity values of 3.5 and 3.4 S m^{-1} were observed for 1.50 M HCl-PANI and 1.25 M HCl-PANI respectively. The highest Seebeck coefficient value of 1.4 $\times 10^{-3}$ V K^{-1} was observed for 1.25 M HCl doped PANI at 303 K. 1.25 M HCl-PANI provided the best thermoelectric properties among the HCl concentrations studied, with a power factor of 6.66 x 10^{-6} W m^{-1} K^{-2} at 303 K.

Keywords: Thermoelectricity, Polyaniline, Chemical oxidative Polymerization, Electrical Conductivity, Seebeck Coefficient

This work was supported by the University of Peradeniya Research Grant (URG/2022/58/S) and Post Graduate Institute of Science Research Grant (PGIS/2022/04)