SYNERGISTIC ENHANCEMENT OF THERMOELECTRIC PERFORMANCE THROUGH ONE DIMENSIONAL HYBRID NANOCOMPOSITES WRAPPED NICKEL OXIDE DECORATED MULTI WALLED CARBON NANOTUBES WITH POLYPYRROLE

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Given the drawbacks of organic materials' thermoelectric (TE) conversion efficiency, an approach has been made in this study to synthesize a hybrid organic-inorganic material based on polypyrrole (PPy), multi-walled carbon nanotubes (MWCNTs) and nickel oxide nanoparticles (NiO). The nanocomposite is formed through three steps: MWCNTs functionalization via diazonium salt grafting of 5-amino-1,2,3-benzene tricarboxylic acid; in situ generation on their surfaces of NiO nanoparticles with a homogenous distribution; the chemical polymerization of pyrrole using methyl orange as templating and dopant to wrap the MWCNTs-$(COOH)_3$-NiO. To explore the structural and physical properties of the fillers and the nanocomposites, X-ray diffraction (XRD), Transmission electron microscopy (TEM), Raman spectrometer, Fourier transform infrared spectroscopy (FTIR), and X-ray photoelectron spectroscopy (XPS) were used. Thereby investigating the electrical conductivity (σ), Seebeck coefficient (S), and thermal conductivity (κ) at room temperature, a promising improvement was observed in PPy-MWCNTs-$(COOH)_3$-NiO compared to pure PPy. The observed enhancements in TE properties ($ZT_{PPy-MWCNTs-(COOH)_3-NiO} = 1.51 \times 10^{-2}$) are attributed to the presence of NiO, which acts as a dopant and improves the charge carrier density in the nanocomposite; this result could be increased at higher temperatures. Overall, these results demonstrate the potential of our approach for developing high-performance TE materials with applications in energy harvesting and waste heat recovery. Furthermore, this approach offers the potential for scalability and reproducibility, making it a promising method for large-scale fabrication of high-performance composites.

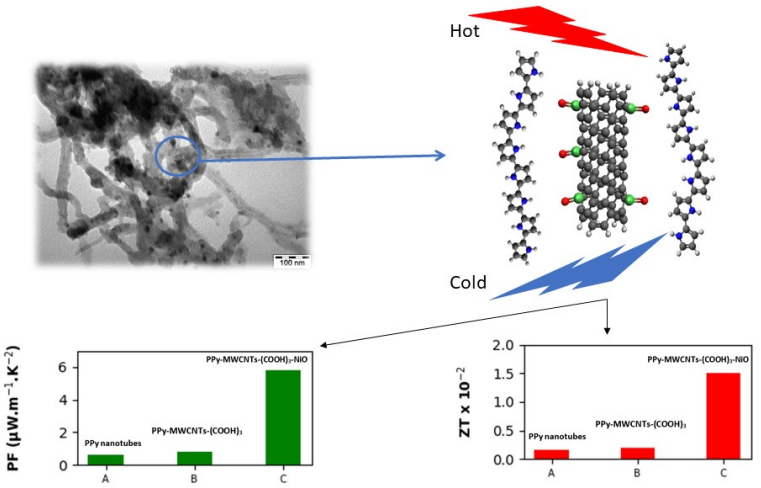

Fig. 1. Graphical abstract of the synthesized material and its TE performance.