Developing Printable Thermoelectric Materials Based on Graphene Nanoplatelet/Ethyl Cellulose Nanocomposites

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Abstract

Thermoelectric (TE) materials have drawn a lot of attention as a promising technology to harvest waste heat and convert it into electrical energy [1]. Recently, the interest in organic thermoelectrics materials is rapidly increasing because they have benefits such as light weight, low thermal conductivity, and high flexibility. Up to now, most of the attention was on conducting polymers, like P3HT, PEDOT, but these materials have limited stability, which has hindered their widespread applications. [2]. Herein, an efficacious processing strategy to fabricate printable TE materials has been developed with Ethyl cellulose (EC), a non-conducting polymer, as the polymer matrix and with Graphene nanoplatelets (GNPs) as fillers. EC, one of the cellulose's derivatives, has been widely used as a binder in the printing pastes [3]. In contrast with conducting polymers, EC is more stable, easy processable, green, and economical. The conductive pastes with different filler contents have been fabricated. The weight ratio of GNPs and EC were ranged from 0.2 to 0.7. The trend of electrical conductivity as a function of W_{GNPs} /W_{EC} represents percolation behavior. However, the Seebeck coefficients of all of the samples were in the range of 15 to 22 μV/K. The highest electrical conductivity and power factor at room temperature (355.4 S/m and 254.0 nW/mK^2, respectively) was obtained for the ratio of 0.7. Moreover, a 3D structure form (cylindrical pellet) from the highest conductive paste was also fabricated. The proposed technique demonstrates an industrially feasible approach to fabricate different geometries and structures for organic TE modules. So, this approach could provide a good reference for production of high efficiency, low-temperature, lightweight, low-cost, TE materials. So, this approach could provide a good reference for the development of high-efficiency, fast, easy and cost-effective method toward upscaling.

References

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[2] Chen G, et al, J. Mater. Chem C, 5 (2017) 4350-60
[3] P. Mariani, Semicond. Sci. Technol, 30 (2015) 104003

Figures

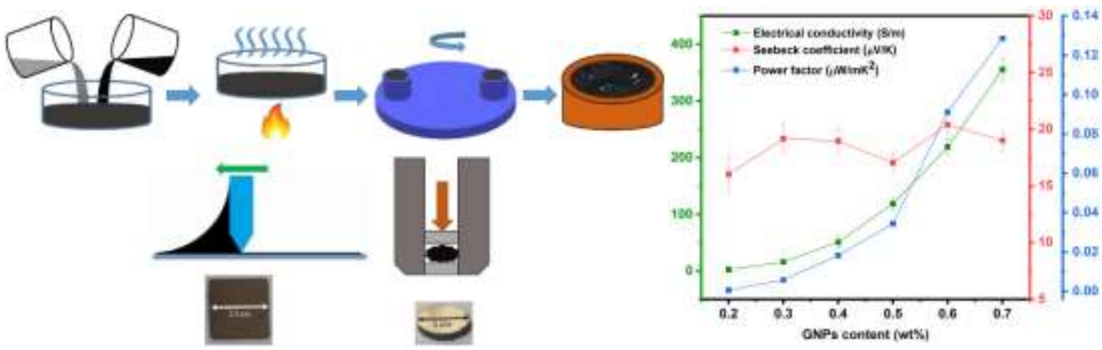

Figure 1: (left) Schematic representation for the preparation of the devices; (right) TE properties of GNPs/EC nanocomposites as a function of GNPs content at room temperature