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Polymer-based Thermoelectric Devices

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ABSTRACT

Currently, over 50% of all energy generated in the US is lost as waste heat, and thermoelectric generators offer a promising means to recoup some of this energy, if their efficiency is improved. While organic thermoelectric materials lack the efficiency of their inorganic counterparts, they are composed of highly abundant resources and have low temperature processing conditions. Recently, a new class of redox-active polymers, radical polymers, has exhibited high electrical conductivity in an entirely amorphous medium. In addition, these radical polymers have a simple synthetic scheme and can be highly tunable to provide desired electrical properties. In this study, the thermoelectric properties of a nitroxide radical-based polymer, poly(2,2,6,6-tetramethylpiperidinyloxy methacrylate) (PTMA), is evaluated in a doped state. 4-ethylbenzenesulfonic acid (EBSA) is used to dope PTMA solutions. The Seebeck coefficient and conductivity measurements were collected to calculate the thermoelectric power factor of the material at an average temperature of 40 ˚C. We expect to find that doped PTMA has a peak power factor of ~10^{-2} μW m^{-1} K^{-2}. While these power factor values would not exceed a state-of-the-art organic semiconductor, they would show that radical polymers are a viable alternative to π-conjugated semiconducting polymers. These redox-active polymers are still a new type of semiconducting polymer; therefore, this study could suggest that further research is necessary to determine their full capabilities and the radical solutions they may have to offer.

KEYWORDS

Radical polymers, thermoelectric devices, thermoelectric power factor, doping, polymer semiconductor