Flexible Thermoelectric Paper and its thermoelectric generator from Bacterial Cellulose/Ag2Se Nanocomposites

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Abstract

In this research, a flexible thermoelectric paper was fabricated from bacterial cellulose/silver selenide (BC/Ag_2Se) nanocomposites. Ag_2Se particles were *in situ* synthesized in the network of BC nanofibers. Several synthesis parameters that crucially affect the formation of Ag_2Se particles in the BC structure were investigated to understand the phase formation mechanism. Under the optimized conditions, the BC/Ag_2Se paper with a large proportion of Ag_2Se up to 75 wt.% was successfully obtained. The *in situ* synthesis limits the Ag_2Se formation within the nanopores of the BC structure. As a result, the sub-micro size Ag_2Se particles with narrow size distribution were homogeneously dispersed in the BC nanofiber network. The microstructure was further improved by hot-pressing, which increase the density of the BC/Ag_2Se paper and make the BC layered structure more compacted. These contributed to a significant enhancement of the thermoelectric properties, with the electrical conductivity of 23000 S/m and the Seebeck coefficient of -167 μV/K at 400 K. The power factor was 642 $\mu W/mK^2$ at 400 K, a very high value compared to other flexible thermoelectric research. The measurement of thermal conductivity yielded the κ value of 0.36 W/mK at 400 K, which led to the maximum *ZT* of 0.70 at 400 K. To demonstrate the thermoelectric conversion, five BC/Ag2Se paper pieces were connected in series to construct a thermoelectric module. The module is very flexible and can be curved to attach to any arbitrary shape of the hot/cold surfaces. In addition, the process for fabricating the BC/Ag_2Se paper is scalable without any use of advanced or expensive instruments. This makes it a very attractive choice as a flexible TEG.