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Tellurium Nanowires / Reduced Graphene Oxide Composite Films for Flexible Thermoelectrics

Abstract

As the cost-effective substitute of graphene, the reduced graphene oxide (RGO) with adjustable electronic structure and electrical conductivity [1-2] is quite suitable for preparing flexible thermoelectric composite films. In this work, using HBr solution as reducing agent, the water-processable RGO sheets are synthesized two types of composite films are prepared using RGO sheets with high electrical conductivity and tellurium nanowires (Te NWs) with large Seebeck coefficient [3] as active components. The first thermoelectric composite film is fabricated by mixing and drop-casting the dispersions of RGO sheets and Te NWs on glass substrate. The redox reaction between RGO sheets and Te NWs during annealing composite films in N_2 can lead to a simultaneous improvement of σ and S. With optimization, the electrical conductivity and Seebeck coefficient can reach 633 S/m and 382 μV/K, respectively, pushing the power factor value up to 68.4 μW/(mK^2). Secondly, highly-flexible RGO/Te NWs composite films with layered structure are fabricated via vacuum filtration. The electrical conductivity and Seebeck coefficient of the optimized hybrid film can reach 978 S/m and 286 μV/K, respectively, and the resulted power factor value up to 80 μW/(mK^2) at 40 ^{o}C. Meanwhile, the possibe carrier energy filtering effect between the RGO sheets and Te NWs is also investigated. This work provide effective access to high-performance and flexible TE films based on RGO sheets and inorganic semiconductors.

References

[1] J. Gao, C. Y. Liu, L. Miao, X. Y. Wang and Y. Chen, J. Electron. Mater., 45 (2015), 1290.
[2] P. V. Kumar, M. Bernardi and J. C. Grossman, ACS Nano, 7 (2013), 1638.
[3] J. Gao, C. Y. Liu, L. Miao, X. Y. Wang, C. Li, R. Huang, Y. Chen and S. Tanemura, Synth. Met., 210 (2015), 342.

Figures

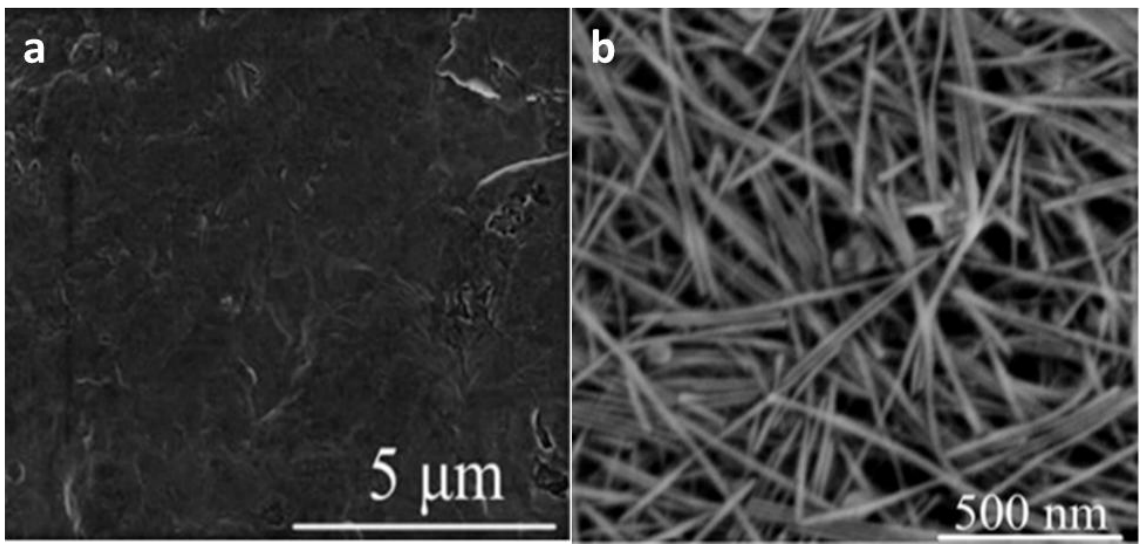

Figure 1: SEM images of RGO sheets and Te NWs.

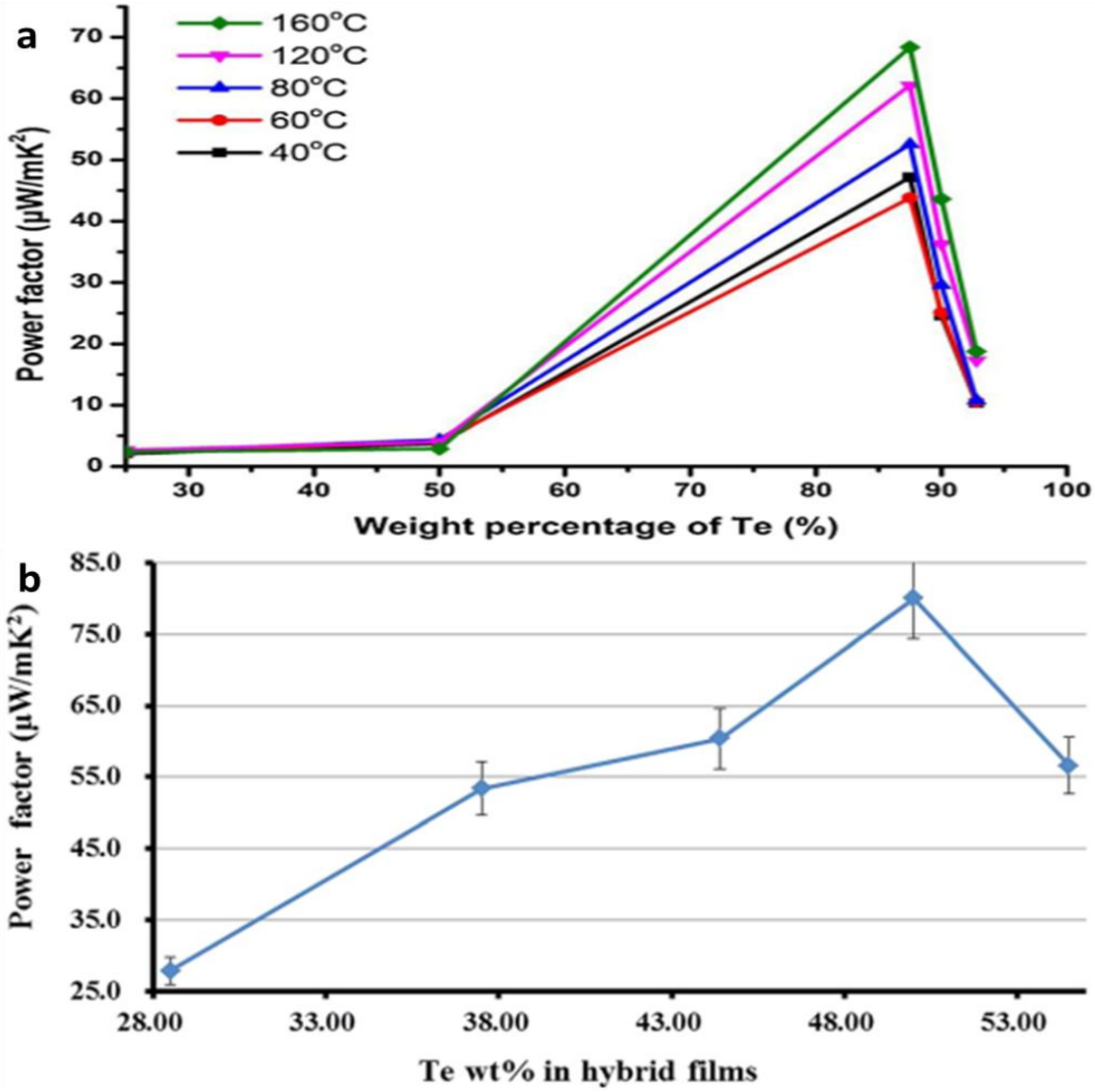

Figure 2: Power factors of mixed composite film and layered-structure composite film.