

Accepted Manuscript

Full Length Article

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Jianwen Chen, Xiucui Wang, Xinmei Yu, Yun Fan, Zhikui Duan, Yewen Jiang, Faquan Yang, Yuexia Zhou

PII: S0169-4332(18)30955-3
DOI: <https://doi.org/10.1016/j.apsusc.2018.04.009>
Reference: APSUSC 39008

To appear in: *Applied Surface Science*

Received Date: 7 September 2017
Revised Date: 15 March 2018
Accepted Date: 2 April 2018

Please cite this article as: J. Chen, X. Wang, X. Yu, Y. Fan, Z. Duan, Y. Jiang, F. Yang, Y. Zhou, Significantly improved dielectric performances of nanocomposites via loading two-dimensional core-shell structure $\text{Bi}_2\text{Te}_3@\text{SiO}_2$ nanosheets, *Applied Surface Science* (2018), doi: <https://doi.org/10.1016/j.apsusc.2018.04.009>

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Significantly improved dielectric performances of nanocomposites via loading two-dimensional core-shell structure

$\text{Bi}_2\text{Te}_3@\text{SiO}_2$ nanosheets

Jianwen Chen^a, Xiucui Wang^{a*}, Xinmei Yu^{a*}, Yun Fan^a, Zhikui Duan^a, Yewen Jiang^a,
Faquan Yang^a and Yuexia Zhou^a

^aSchool of Electronic and Information Engineering, Foshan University, Foshan, 528000, China

*Corresponding author: Xiucui Wang, E-mail: wxc5168@163.com;

Xinmei Yu, E-mail: labxmyu@163.com;

Abstract

Polymer/semiconductor-insulator nanocomposites can display high dielectric constants with a relatively low dissipation factor under low electric fields, and thus seem to promising for high energy density capacitors. Here, a novel nanocomposite films is developed by loading two-dimensional (2D) core-shell structure $\text{Bi}_2\text{Te}_3@\text{SiO}_2$ nanosheets in the poly (vinylidene fluoride-hexafluoro propylene) (P(VDF-HFP)) polymer matrix. The 2D Bi_2Te_3 nanosheets were prepared through simple microwave-assisted method. The experimental results suggesting that the SiO_2 shell layer between the fillers and polymer matrix could effectively improve the dielectric constant, dielectric loss, AC conductivity, and breakdown strength of composites films. The composite films load with 10 vol.% 2D $\text{Bi}_2\text{Te}_3@\text{SiO}_2$ nanosheets exhibits a high dielectric constant of 70.3 at 1kHz and relatively low dielectric loss of 0.058 at 1kHz. The finite element simulation of electric field and electric current density distribution revealed that the SiO_2 shell layer between the fillers and polymer matrix could effectively improve the energy loss, local electric field strength, and breakdown strength of composite films. Therefore, this work will provide a promising route to achieve high-performance capacitors.

Keywords: Nanocomposites; Dielectric properties; Finite element simulation; capacitors

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