Lead- free $Cs_3Bi_2Br_9$@EVA Nanocomposite based Triboelectric Nanogenerator for Energy Harvesting and Tactile Sensing

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ABSTRACT

Redefining energy harvesting solutions, herein a sustainable triboelectric nanogenerator has been developed by integrating lead-free $Cs_3Bi_2Br_9$ nanoparticles into ethylene co-vinyl acetate (EVA) through green solution casting method. Comprehensive characterization confirms the material's enhanced properties contributing to device performance. The optimized device efficiently converts ambient motion into electrical output along with powering microelectronics, charging capacitors and acting as self-sufficient tactile sensor. This work demonstrates a green chemistry approach into developing multifunctional energy harvesting devices with potential in wearable electronics, biomedical sensors and environmental monitoring.

INTRODUCTION

- Various polymers, including PVA, PVDF, PMMA, PU, PTFE, nylon, and other organic-inorganic composites, have been employed in the development of TENGs. In search for sustainable polymers, it was observed that modifying the vinyl acetate content, polarity of the matrix and affinity of EVA for nanofillers can be improved, thereby having impact on the performance of TENGs
- To further enhance TENG performance, researchers have incorporated semiconducting nanomaterials to boost electrical conductivity.
- From green chemistry perspective, $Cs_3Bi_2Br_9$ embedded polymer nanocomposites have shown excellent triboelectric and piezoelectric properties in the fabrication of piezoelectric nanogenerators and hybrid triboelectric and piezoelectric energy harvesters.
- Thus, in this context, $Cs_3Bi_2Br_9$ was used to prepare flexible and stable lead-free $Cs_3Bi_2Br_9$@EVA nanocomposites for energy harvesting and tactile sensing applications.

RESULT AND DISCUSSION

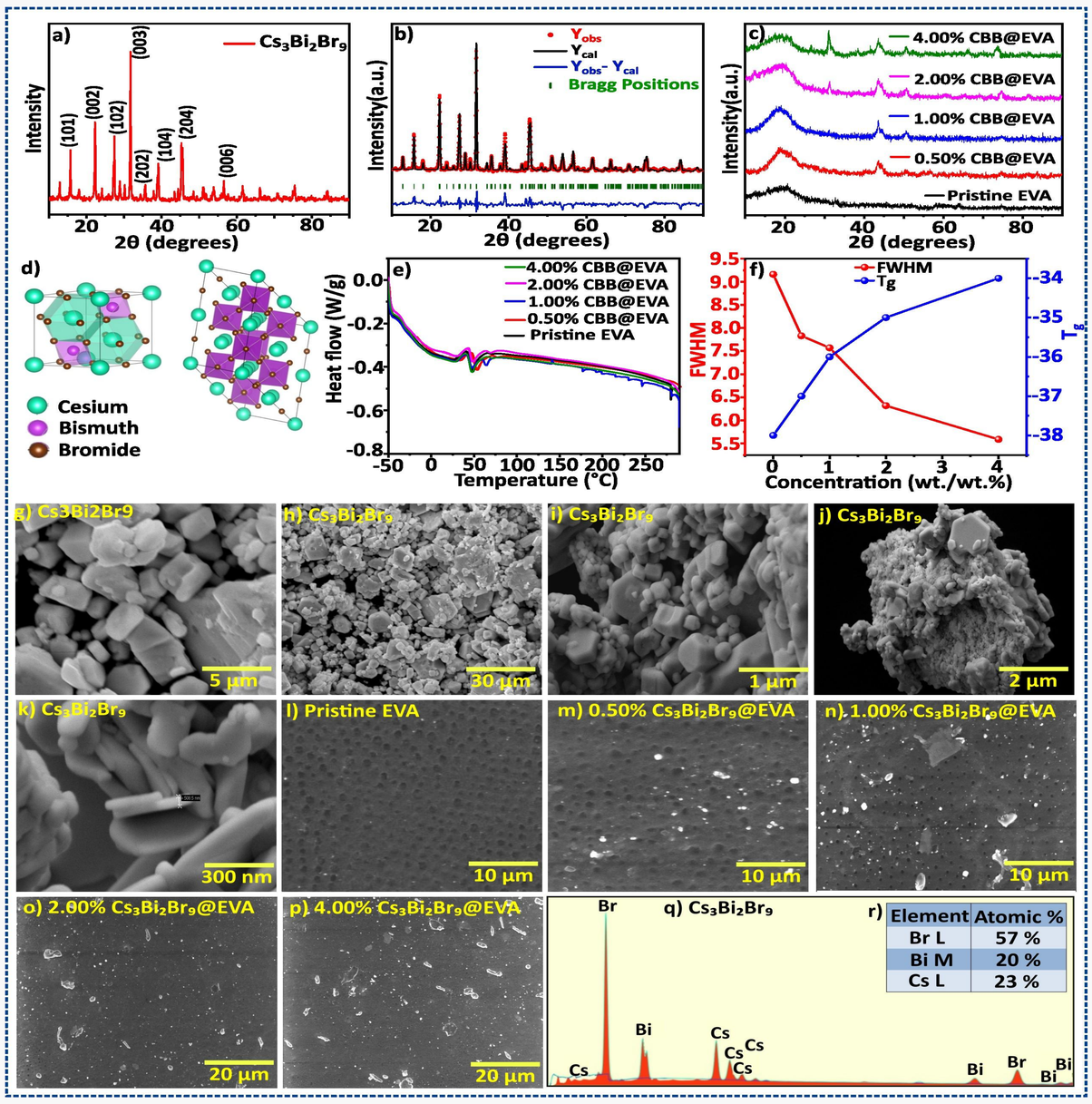

Figure 2. (a) XRD diffractogram of CBB (b) Rietveld refinement of CBB nanoparticles; (c) XRD spectra of CBB@EVA nanocomposite MP/PU containing 0.0, 0.5, and 4.0 wt./wt. % of MP (d) Crystal structure of CBB (d) DSC thermogram (f) Correlation between FWHM and Tg; (g-k) FE-SEM and SEM images of CBB nanoparticles; (l-p) SEM images of CBB@EVA nanocomposite with varying concentrations of CBB (0.0 to 4.0 wt./wt.%); (q) EDS elemental mapping of CBB nanoparticles; (r) atomic % table

SYNTHESIS AND METHODOLOGY

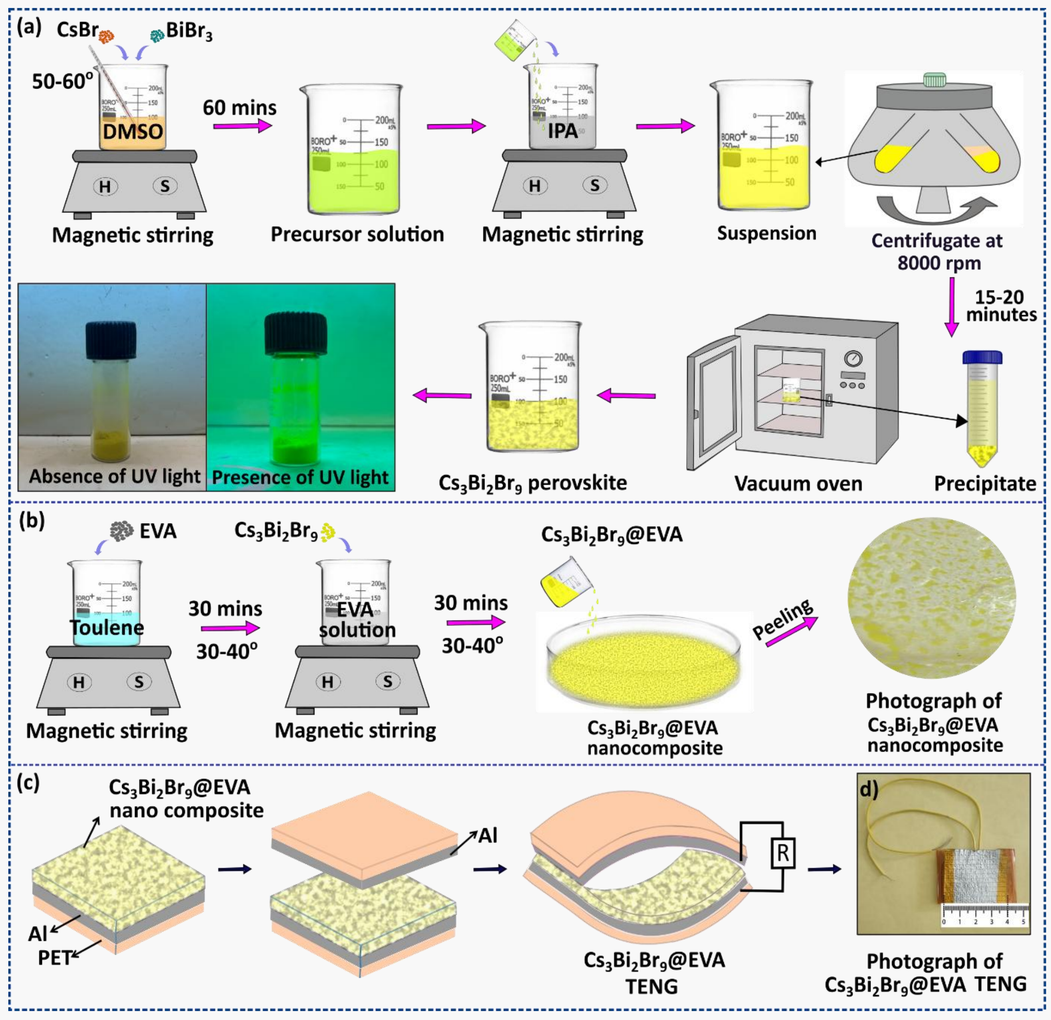

Figure 1. (a) Diagrammatic representation of synthesis of (a) nanoparticle and (b) nanocomposite (c) Schematic representation of TENG fabrication (d) Assembled CBB-TENG

APPLICATION

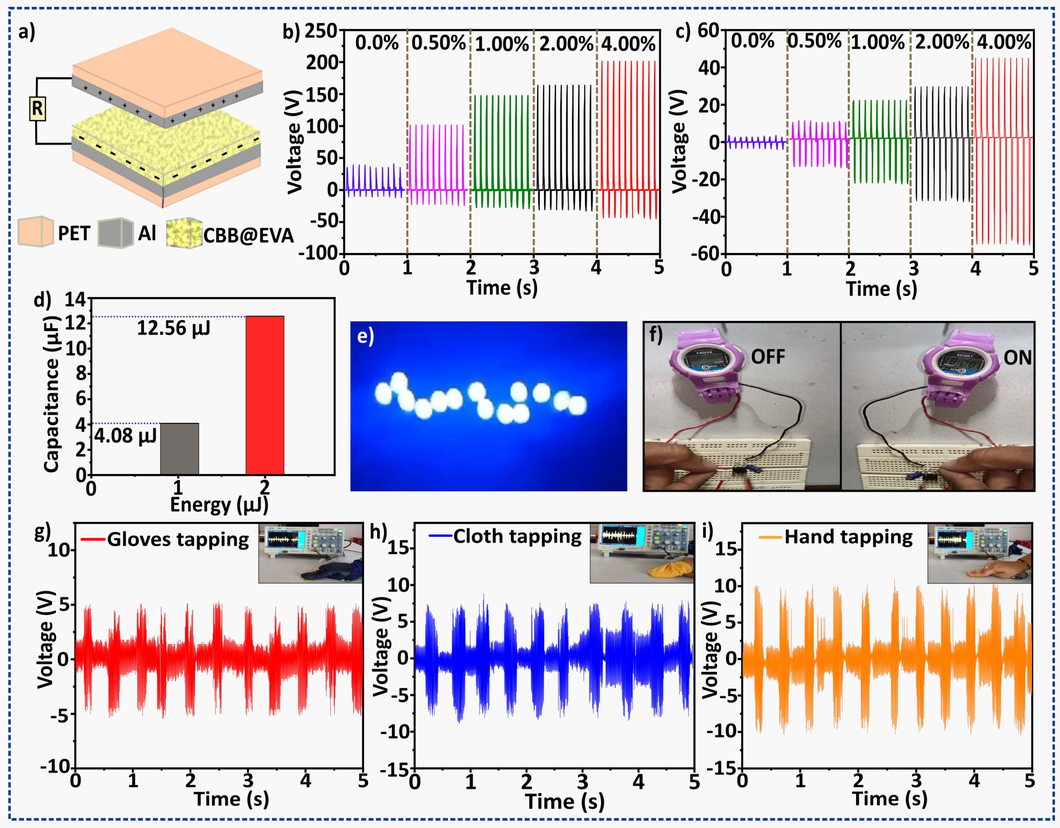

Figure 3. (a) Fabricated TENG; Output provided by TENG (b) voltage (c) current ; Application: (d) Energy stored in capacitors (e) LEDs powered (f) Watch charged and (g-i) Output performance provided as tactile sensor

CONCLUSION

In this work all-inorganic lead-free $Cs_3Bi_2Br_9$ (CBB) perovskite nanoparticles were effectively synthesized and embedded into an ethylene-co-vinyl acetate (EVA) matrix using green solution casting method. The practical functionality of the optimized CBB-TENG was demonstrated efficient energy harvesting along with capabilities to serve as tactile sensor. This study outlines a comprehensive framework for self-powered devices, driven by green chemistry and purposeful design for next generation eco-conscious energy solutions.

REFERENCE

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