2D Hexagonal Boron Nitride synthesized *via* Scalable High-Pressure Homogenization for Sustainable Triboelectric Energy Harvesting

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Abstract

The growing demand for low-powered, high-density wearable electronic devices and Internet of Things (IoT) technology necessitates the development of reliable and sustainable energy harvesting systems. Triboelectric nanogenerators (TENGs) have emerged as a promising solution for converting ambient mechanical energy into electrical power suitable for self-powered electronics [1]. Among the various two-dimensional (2D) boron nitride (BN) flakes made from hBN have gained significant attention owing to their exceptional thermos and physicochemical properties [2,3]. In this work, we report the fabrication of a high-performance TENG based on 2D hexagonal boron nitride (hBN) flakes synthesized via a high-pressure homogenization (HPH) technique (**Figure 1**). HPH-derived 2D hBN, employed as an electropositive material, was coupled with fluorinated ethylene propylene (FEP) as the electronegative layer to construct a triboelectric device (**Figure 1**). The resulting TENG delivered a consistent open-circuit voltage of ~135 V and short-circuit current of ~17.0 μA under a mechanical excitation frequency of 5 Hz. Notably, the device achieved a peak power density of 18 W/cm², exceeding the previously reported performance of hBN-based TENGs. TENG also exhibit multifunctional capabilities, including real-time humidity sensing over a wide range (30–100% RH) and mechanical force, and distinguish light from harsh tapping [4-6]. Moreover, it successfully powers small-scale electronics, such as digital thermometers, stopwatches, and calculators. These findings highlight the potential of HPH-engineered 2D hBN as an efficient triboelectric material for next-generation energy-harvesting platforms, promoting advancements in autonomous electronics and sustainable energy technologies.

References

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Figures

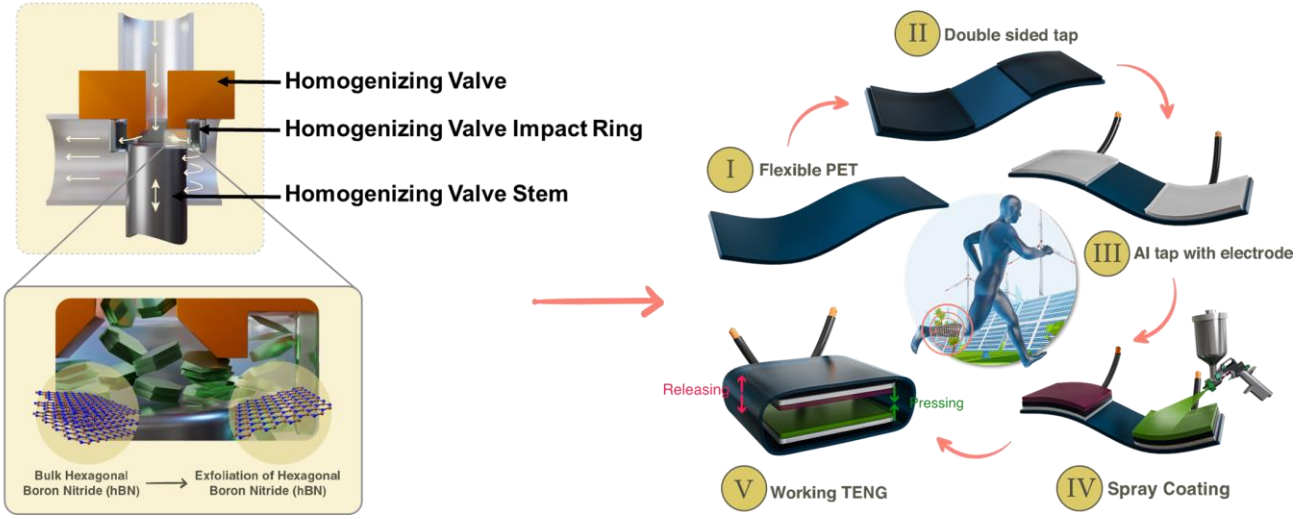

Figure 1. Schematic illustration of HPH-synthesized 2D hBN flakes and their integration into TENG fabrication.