Enhancing Triboelectric Nano-Generators (TENGs) for Sustainable Energy Harvesting

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As climate change nears an irreversible tipping point, projections show that even with solar and wind power deployment, renewable energy production is expected to fall short of global energy demand by 20–25% unless innovative technologies are developed. Triboelectric nanogenerators (TENGs) can address this need using the triboelectric effect, where contact and separation of dissimilar materials generate electricity. This research developed and evaluated a novel, highly efficient TENG engineered through the strategic selection and precise pairing of materials. With the size of an index card, it can generate 16.77 volts from simple tapping. Finger-sized TENG prototypes of various layered structures were fabricated to optimize voltage output, and the selected structure was evaluated on acrylic and PET substrates for further optimization. The result is a novel combination: an electron-accepting layer of electrospun polyvinylidene fluoride nanofibers with molybdenum disulfide nanosheet fillers (to attract electrons); an electron-donating layer of polydimethylsiloxane composite incorporating conductive graphene oxide (for better electricity flow) and sodium dodecyl sulfate (to adjust surface charge). SEM characterizations revealed that the intricate nanofiber structure, efficient filler mixing, enhanced conductivity within these layers, and precisely engineered interfaces were key to the device's impressive voltage output. This emerging technology provides a sustainable way to power small electronics and sensors. From self-powered medical devices to the Internet of Things charged by daily actions, it marks a step toward energy-independent, low-power applications. It also shows potential in civil infrastructure, where ambient mechanical energy from movement can be harvested.

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