Development of an Integrated Textile-Based Triboelectric Nanogenerator for Energy Harvesting from Body Movements

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Abstract: The evolution of wearable electronics has created an imperative need for sustainable energy sources that are flexible, lightweight, and can seamlessly integrate with human activities. In response to this challenge, we present the development of an innovative textile-based triboelectric nanogenerator (TENG), utilizing Polypropylene (PP), Nylon and copper conductive yarn. This novel TENG is developed using advanced knitting technology to integrate both types of yarns into a single-layered fabric TENG, optimizing the triboelectric effect through contact and separation from body movements. The PP filament, known for its high electron affinity, acts as a negative triboelectric material, and the nylon is utilised as a positive triboelectric material, while the copper yarn serves as an effective electrode due to its excellent conductivity (Figure 1). The integration process ensures that these materials maintain their distinct properties while functioning cohesively within the fabric matrix. The unique structure of the fabric allows it to efficiently scavenge energy from various human motions, including sliding, bending, and stretching. The flexibility, durability, and integration of TENG with the garments make it a practical and user-friendly energy-harvesting system. The energy harvesting capability of beveloped TENG has been demonstrated by powering a digital watch from the energy generated by simple hand tapping movement. The integration of this technology in everyday clothing could mark a paradigm shift in how we interact with and power our wearable devices, paving the way for a new era of energy-efficient and eco-friendly wearable technology.

Keywords: *Triboelectric Nanogenerator, Textile-based Energy Harvesting, Knitting Technology, Wearable Energy Harvesting.*

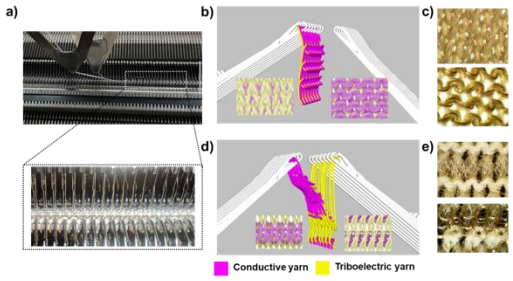

Figure 1. a) The needle arrangement on the Shima Seiki knitting machine, the simulated structural configuration, and optical images of b-c) plating, d-e) ridge knit structure.