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Preparation of β-Polyvinylidene Fluoride Film for Self-Charging Lithium-Ion Battery

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Abstract : In recent years the development of sustainable energy sources is getting extensive research interest due to the ever-growing demand for energy. As an alternative energy source to power small electronic devices, ambient energy harvesting from vibration or human body motion is considered a potential candidate. Despite the enormous progress in the field of battery research in terms of safety, lifecycle and energy density in about three decades, it has not reached the level to conveniently power wearable electronic devices such as smartwatches, bands, hearing aids, etc. For this reason, the development of self-charging power units with excellent flexibility and integrated energy harvesting and storage is crucial. Self-powering is a key idea that makes it possible for the system to operate sustainably, which is now getting more acceptance in many fields in the area of sensor networks, the internet of things (IoT) and implantable in-vivo medical devices. For solving this energy harvesting issue, the self-powering nanogenerators (NGS) were proposed and proved their high effectiveness. Usually, sustainable power is delivered through energy harvesting and storage devices by connecting them to the power management circuit; as for energy storage, the Li-ion battery (LIB) is one of the most effective technologies. Through the movement of Li ions under the driving of an externally applied voltage source, the electrochemical reactions generate the anode and cathode, storing the electrical energy as the chemical energy. In this paper, we present a simultaneous process of converting the mechanical energy into chemical energy in a way that NG and LIB are combined as an all-in-one power system. The electrospinning method was used as an initial step for the development of such a system with a β-PVDF separator. The obtained film showed promising voltage output at different stress frequencies. X-ray diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FT-IR) analysis showed a high percentage of β phase of PVDF polymer material. Moreover, it was found that the addition of 1 wt.% of BTO (Barium Titanate) results in higher quality fibers. When comparing pure PVDF solution with 20 wt.% content and the one with BTO added the latter was more viscous. Hence, the sample was electrospun uniformly without any beads. Lastly, to test the sensor application of such film, a particular testing device has been developed. With this device, the force of a finger tap can be applied at different frequencies so that electrical signal generation is validated.

Keywords : electrospinning, nanogenerators, piezoelectric PVDF, self-charging li-ion batteries
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