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E-Beam Irradiation on Piezo-PVDF: Beneficial Effect for Harvesting Energy Application

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Poly(vinylidene fluoride) (PVDF), is one of the most attractive semi-crystalline polymer owing to its remarkable pyro-, piezo- and ferro-electric properties. These thermal and electrical properties results of an appropriate crystalline phase arrangement inside PVDF bulk. PVDF polymorphism is well-known and consists of four crystalline phases, named β , γ , δ and ϵ phases. In β phase, PVDF chains are arranged in pairs adopting an all-trans planar zigzag conformation, resulting in a significant net dipole moment. Whatever the phases, poling is a necessary ultimate step to align whole microscopic net dipole moment to the direction of the electric field.

Since the discovery of the piezoelectric properties of PVDF in 1969, many research groups immediately understood the potential applications of the polarized β -PVDF as sensors and actuators. In the recent years piezoelectric PVDF membranes have experienced a resurgence of interest for energy harvesting. However, their use as electrical generators has remained rather limited due to their relatively low power output, despite the large reversible elastic deformation.

Starting from polarized PVDF film, we have shown that irradiation energy doses lower than 100kGy is a competitive way to modify structural components of the PVDF i.e its elasticity without affecting the electroactive properties. The increase of crystallinity obtained for range doses lower than 25kGy could be exploited to enhance the piezoelectric response after a further poling step. Moreover, the results suggest that irradiation doses higher than 25kGy reducing the crystallites size affecting the piezoelectric response. Homemade pressure-cell system was realized to correlate the bending deformation on the PVDF membrane with the output voltage. FT-IR, DSC and XRD techniques give new insights on which crystalline part or structural change contributes at the surplus output voltage.

Country/Organization invited to participate

France

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