Radiation processed conducting polymer nanocomposites for artificial skin applications: An investigation of structure-property correlation

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Skin inspired electronics has fuelled development of new generation of materials with skin mimetic properties. Polymer nanocomposites are one of the choices for these materials due to the ease of tailoring the properties for specific application. A suitable combination of polymer matrix and nanofiller can provide best possible electrical and mechanical performance of the devices. Microstructural characteristics involving interaction between different moieties, interface interaction and compressibility can be tuned to optimize the electromechanical properties of the composite. Radiation processing is one of the techniques used to modify the microstructure of polymers. Apart from being solvent/chemical- free in nature, the technique is very much viable for mass-scale processing of polymer nanocomposites. We employ gamma radiation to modify polymer nanocomposites for stretchable piezoresistive sensors. Polymer nanocomposite with different combination of polymers and nanofillers and optimized radiation dose are prepared to achieve the best possible mechanical strength and electrical conductance. We employ positron annihilation spectroscopy to investigate microstructural changes of the nanocomposites processed with gamma radiations. Other techniques like rheology and dielectric relaxation spectroscopy have also been used to probe change in microstructural characteristic under compressive and tensile strain in addition to mechanical and electrical properties of the composites. A particular emphasis is given on investigating the change in free-volume, polymer chain relaxation and segmental dynamics in polymer composites after radiation treatment. This paper presents a correlation between microstructural changes and piezo-resistivity of the radiation processed conducting polymer nanocomposites.