INVESTIGATION OF THE AMORPHOUS DOMAIN COOPERATIVITY IN COMPLEX COPOLYMER NANOFIBERS BY TEMPERATURE MODULATED DSC

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ABSTRACT

Electrospinning is one of the cheapest and easiest ways to produce polymer nanofibers. Although the process is relatively simple, there are a large number of electrical and mechanical stresses occurring in the polymer during the process. This can lead to the molecular chains in the fiber being highly oriented or in the case of phase segregating polymers lead to a non-equilibrium morphology. The molecular orientation might influence the relaxation of the amorphous phase of semi-crystalline materials[1].

In the present study, the aim was to investigate and focus on the molecular mobility and cooperativity of the amorphous domain of electrospun polymer fibres by analyzing the main relaxation processes related to the amorphous phase through Temperature Modulated Differential Scanning Calorimetry (TMDSC). Amphiphilic graft copolymers of polyacrylonitrile (PAN) and poly(dimethyl siloxane) (PDMS) where used in this study [2]:

- PAN powders & PAN nanofibers with a semi-crystalline morphology
- PAN-g-PDMS powders & PAN-g-PDMS nanofibers with very complex phase morphologies which show phase segregations as well as a semi-crystalline morphology of the PAN phase

The TMDSC allows the determination of the glass transition temperature (T_g), the specific heat capacity step (ΔC_p) as well as the Cooperative Rearranging Region size (CRR) according to the Donth's approach [3]. The powders show a slight decrease of the glass transition with an increasing PDMS content indicating that the PDMS grafts have a plasticising effect. On the other hand, the PDMS cannot be considered as a plasticizer for the fibers due to an increase of the glass transition temperature when the PDMS content in the electrospun polymer nanofibres increases. Moreover, evidence is found in the data that the fibers present a system with three phases: crystalline, rigid amorphous phase and mobile amorphous phase.

References:

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