

Relaxation of nanodeformations induced in polycarbonate thin films as a function of temperature: a comparative study

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In this work, we report on the relaxation of nanometer-sized deformations induced by single ion impacts on the surface of monodisperse ($M_w=60\text{ku}$) PC thin films ($\approx 100\text{nm}$ thick). The characteristic relaxation times $\tau(T)$ of distinct parts of the nanodeformations were probed at temperatures (T) close to the glass transition zone. The deformations were produced at the surface of the samples by the impact of 18MeV Au^{7+} ions at low fluences ($\sim 10^9\text{cm}^{-2}$) in exposures of approximately 0.5s. The samples were held at the irradiation T for a predetermined time and immediately quenched to room temperature in order to freeze the morphology of the surface defects. A series of samples was irradiated at each T, comprising distinct periods of time in order to study the thermal stability of nanodeformations and to map the different stages of the relaxation process. The morphology and size of the surface defects were determined *ex-situ* by means of atomic force microscopy in the tapping mode (topographic and phase image). The different regions of the nanostructures (crater, rim and tail) relax at different rates, suggesting different chemical structures. The relaxation dynamics of the length, maximum width and height of the tails were well described by a stretched exponential law ($\propto \exp(-t/\tau)$), where τ is identified as a characteristic relaxation time. Best fits were obtained with $\beta \approx 0.5$ at high temperatures and $\beta = 1$ at low temperatures. On the other hand, the relaxation of the rims and craters were much slower, probably because of a strong chemical modification and crosslinking of the chains around of the core of the impact. The data were compared with results previously obtained to PMMA and shows similar characteristics suggesting that this behavior is a general trend in deformations produced by single ions in polymer surfaces.

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