The Effect of Loading Strain Rate on Nanoindentation Response of RTM6 Epoxy Polymer: Experimental and Computation Research

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In this paper nanoindentation response of a commercial epoxy resin (RTM6) is investigated by combining physical and computational experiments. A series of nanoindentation tests at different constant loading strain rates were carried out and corresponding mechanical parameters determined by the Oliver-Pharr approach. Since glassy polymers exhibit time-dependent yielding and knowing that hardness is directly related to yield stress, an increasing trend in indentation hardness with increasing strain rate would be expected. Conversely, experimental results show the opposite trend. In order to elucidate the cause of such apparent physically inconsistent results, finite element simulations experiments were performed. A nine-parameter elastic visco-plastic constitutive model (EVP-9) was calibrated from uniaxial stress-strain data available in literature and used to describe the visco-plastic nanoindentation response of the RTM6 epoxy system. It appears that inconsistencies in strain rate trends are due to the intrinsic visco-plastic nature of epoxy resin and not to spurious displacements measurements arisen from thermal drift effects. Our results undermining the appropriateness of Oliver-Pharr approach to investigate time-dependent properties like indentation hardness in glassy polymers.