MECHANICAL CHARACTERIZATION OF POLYDIMETHYLSILOXANE NANOCOMPOSITE

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Introduction. Nanocomposites exhibit excellent improved properties when comparing with the unmodified polymers or common composites based on microparticles (1). The principal application of inorganic fillers mixed into polymers is the improvement of its mechanical structure. In this context, one of its applications is the realization of complex microfluidics integrated in in bioMEMS and lab-on-a-chip (LOC). This is accomplished when using nanocomposite polydimethylsiloxane (PDMS) (2). The main difficulty of mixing process is commonly the effective dispersion of silica nanoparticles into polymer matrix, as they tend to agglomerate (3,4). Here, we study nanocomposite characteristics obtained when implementing particular mechanical mixture procedures to achieve proper dispersion.

Methodology. Here the traditional and simplest method is used for preparing polymer/silica nanocomposites, called blending. It consists of mixing directly silica nanoparticles into the polymer. PDMS elastomer was obtained by mixing it with its curing agent (weight ratio 10:1) and degassed during 10 min. in a vacuum chamber to remove air bubbles. Nanoindentation technique is employed to characterize mechanical properties of nanocomposite PDMS. The so called Oliver-Pharr model was used to estimate the hardness (H) and elastic modulus (E) values using the unloading data of the load-displacement curves (5). The effect of loading rate on H and E values is studied for loading rates 0.5 at 10 mN/min in unmodified PDMS and nanocomposite PDMS with a maximum load of 10 mN, through a three-segment process (hold time 3 s between load and unload segments).

Results. Average values of hardness (H) and elastic modulus (E) are relatively high in PDMS (43 and 62 MPa, resp.) for a loading rate of 1.5 mN/s, then decreasing with the increase of loading rate and reaching almost constant values (9 and 18 MPa, resp.). This behavior is common in elastic materials. Fig.1). The average values in this case are for hardeness 7.26 MPa and for elastic modulus 26 MPa. The unloading rate is the same with that of loading in each case. Whereas the nanocomposite exhibits a not elastic behavior having hardeness values higher than unmodified or pristine PDMS, from 10 to 97 MPa and an almost constant value of elastic modulus.

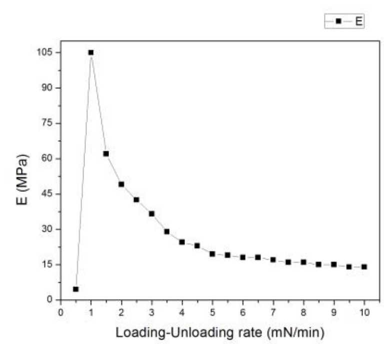

Fig.1 Elastic modulus (E) values for different loading rates of a sample of PDMS.

Conclusions. The properties of nanocomposite PDMS are superior to the pristine PDMS. In particular, it exhibits improved mechanical properties as in this case we obtained values of hardeness higher that the unmodified polymer and a good value of elastic modulus enough to building complex microfluidic systems as application.

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