Modulus measurements via Nanoindentation – a guide for parameter settings for testing polymers

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Abstract

Knowing local differences in Young's Modulus and hardness can help us to better understand material behavior and heighten the precision of simulations and fracture mechanic evaluations. One tool for gathering information on a small scale is nanoindentation, which is already widely used and established. The Oliver and Pharr Method is also widely used for evaluating stiffer, linear elastic materials, like metals and ceramics.(1) Soft, non-linear and time dependent materials require some adjustments to the testing parameters to achieve reasonable results. (2–4) During these measurements, the unloading speed and the holding time are crucial. The holding time should be kept as short as possible to minimize the influence on the measured hardness and Young's Modulus, while still being long enough to avoid the formation of a "nose" due to the viscous behavior of the material. The unloading speed should be as fast as possible since the unloading segment is used to calculate Young's Modulus. Furthermore, the power law Fit used for the Oliver Pharr evaluation does not sufficiently represent the measured data in some cases.(5) A detailed parameter study for loading, unloading speeds, and holding times on three different polymers, polyethylene, polypropylene, and polymethyl methacrylate, covering a broad spectrum of mechanical properties in polymer science, is presented. The use of different fitting parameters for the unloading curve and their effect on the results obtained using Oliver and Pharr's Method are discussed. References
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