A novel nanomanipulation technique for measuring the mechanical properties of single nanoparticles

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ABSTRACT

A novel nano-manipulation technique has been developed to measure the mechanical properties of single nano-particles. The principle of this technique is to compress single nano- particles between two flat surfaces made of a glass slide and the tip of a pre-calibrated glass cantilever inside the chamber of an Environmental SEM, so that the force being imposed on them and their deformation can be determined by a series of images of the particles and the cantilever. The cantilever is held by a nano-manipulator that has a claimed resolution of 0.5nm.

The novel nano-manipulation technique and a previously developed micromanipulation technique were first used to measure the force required to compress single micro-particles (ranging from 1 to 3 μm in diameter) of methacrylic acid copolymer Eudragit E100 to different deformations under dry mode respectively, in order to validate results from the former. Results showed that there is no significant difference in the data obtained using these two techniques, which implies that the new nano-manipulation technique is highly reliable.

The new technique was then applied to single poly(methyl methacrylate) (PMMA) particles ranging from 530 nm to 950 nm in diameter. They were compressed and held, compressed and released, and compressed to different deformations, and the force imposed on the particles were determined simultaneously. This work demonstrates the feasibility of measuring the mechanical properties of single nano-particles, and the developed technique can find wide applications in mechanical characterization of different nano-particles.