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Probing nanotubes and red blood cells with laser-induced cavitation bubbles PEDRO QUINTO-SU, XIAOHU HUANG, CLAUDIA KUSS, ROBERTO GONZALEZ, PETER PREISER, TOM WU, CLAUS-DIETER OHL — A spatial light modulator (SLM) is used to simultaneously create arrays of laser-induced cavitation bubbles. The different bubble geometries result in the creation of a directed, transient and strong liquid flow. Due to the fast dynamics of the cavitation bubbles the flow is actuated on very short temporal (μs) and spatial (μm) scales. We show two examples of the use of laser-induced cavitation bubbles to probe and manipulate small objects: multiwalled carbon nanotubes (MWCNT) and red blood cells (RBCs). In the case of MWCNT, we use a pair of bubbles to displace and bend the nanotubes. By measuring the time it takes for the nanotube to recover its original shape we can estimate the flexural rigidity and the bending modulus. The shape recovery is recorded with a high-speed camera at up to 300,000 frames per second (fps). We found the flexural rigidity to be on the range of $0.98 - 6.6 \times 10^{-19}$ Nm^2 and the Young's modulus on the order of 0.06-0.6 TPa for MWCNT with an average diameter of 117.8 ± 6.7 nm and a thickness of 4.6 ± 0.75 nm. A similar approach is used to study the mechanical properties of RBC's, where multiple cells are elongated due to the radial flow induced by a single bubble. We study the shape recovery of the RBCs and find a significant difference when they are treated with an enzyme.

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