Fine tuning nanoparticle spacing in freestanding membranes through ion and electron beams

PONGSAKORN KANJANABOOS, The University of Chicago, ALEXANDRA JOSHI-IMRE, XIAO-MIN LIN, Argonne National Laboratory, HEINRICH JAEGGER, The University of Chicago — Freestanding membranes of ligated nanoparticles can be assembled in a one-step drying-mediated process. These 2D sheets have remarkable mechanical properties, in particular extreme bending flexibility coupled with effective Young’s moduli in the range of 1-20GPa, depending on the nanoparticle and ligand types and sizes. We report on experiments in which used a focused Ga ion beam to strategically place cuts into freestanding monolayer membranes. Exposed to electron beams, the cuts expand and the membranes act as if additional strains were deposited. Given that the exposed membranes behave like strained elastic sheets, we can easily design various strain patterns. With calibration, the electron beam dose serves as a knob to fine-tune interparticle distances in these patterns.