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**Fabrication of Flat Freestanding Silicon Nanomembranes** KYLE MCELHINNY, Materials Science and Engineering and Materials Science Program, DAVID CZAPLEWSKI, Center for Nanoscale Materials, Argonne National Laboratory, GOKUL GOPALAKRISHNAN, Materials Science and Engineering and Materials Science Program, MARTIN HOLT, Center for Nanoscale Materials, Argonne National Laboratory, PAUL EVANS, Materials Science and Engineering and Materials Science Program — Silicon nanomembranes are suspended single crystal sheets of silicon, tens of nanometers thick, with areas in the thousands of square micrometers. Freestanding nanomembranes provide an ideal system for studying the physics of nanoscale crystalline materials and find application in novel electronic and photonic materials and devices. Challenges in fabrication arise due to buckling in response to stresses in the silicon-on-insulator starting material. In equilibrium, the elastic energy of the membrane is minimized by distributing the buckling distortion across the entire membrane. We demonstrate that flat nanomembranes can be created by utilizing a modification of traditional membrane fabrication procedures. This new scheme produces an elastically metastable structure, in which the buckling is redistributed to a small area near the edges of the membrane. An energetically favorable mechanism for this redistribution will be discussed. Membranes with thicknesses from 315 nm down to 6 nm have been fabricated, showing vertical deviations of less than 10 nm across an area covering 100 $\mu$m $\times$ 100 $\mu$m. X-ray scattering experiments performed on these structures demonstrate the importance of the ability to fabricate crystallographically uniform and flat nanomembranes.

Kyle McElhinny
Materials Science and Engineering and Materials Science Program

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