Elastocapillary self-assembly of silicon nanopillars

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Nanostructured materials exhibit fascinating physical properties that can be utilized for many applications, and recently there is a rising interest in using elastocapillary self-assembly of vertically oriented nanopillars to fabricate highly ordered hierarchical structures [1–3] . In this work, dense arrays of silicon nanopillars with different dimensions are used to study the capillary-force-induced structural self-organization. The observed bending and aggregation of nanopillars result from the competition between the elastic restoring energy and the capillary interactions. Different surface functionalizations are applied to fine-tune the delicate balance between the mechanical and interfacial energy, as a result various hierarchical morphologies of the clustered nanopillars can be achieved. Reverse self-assembly is also investigated by chemical removal of native oxide from the silicon structures. After breaking the covalent bonds formed between bridging structures, the deformed silicon pillars can recover to their initial free standing states because the reduced adhesion energy is not sufficient to counter balance the elastic restoring energy. Recovery of big clusters is found to be more challenging, and for heavily bended nanopillars, high resolution TEM inspections reveal stress induced crystal defects which are believed to have a catastrophic effect on reversible self-assembly of crystalline structures.

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