Mechanical Stability of Asymmetric Hybrid Nanostructures

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Asymmetric hybrid structures, such as Janus nanopillars and Lucius prism arrays, have received much attention due to their directional physical properties and applications on artificial adhesives, microfluidics, and optical devices. We recently found that oblique metal deposition as a way to realize hybridized high aspect ratio nanowalls induced a phenomenon known as the lateral buckling. Polymeric nanowalls were prepared with the replica molding technique and metal films, of comparable thicknesses, were then deposited on one side of the polymer nanowalls by vacuum process. During the metal deposition, the Janus nanowalls themselves buckle laterally; this buckling is induced by the compressive residual stress of the metal film deposited as well as geometric confining constraints. Furthermore, we demonstrate a strategy to enhance mechanical stability of such high aspect ratio polymer pillars by modifying the fabrication procedure of hybridized asymmetric structure. The structure is essentially an assembly of nanopillars, the stem region of which is coated with a metal layer and thus strengthened, with the top part of a pillar intact and soft. The structure we present here is inspired by superficial neuromasts of fishes.