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Abstract

Hollow AFM Cantilever with Holes †

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Since its invention, atomic force microscopy (AFM) has enhanced our understanding of physical and biological systems at sub-micrometer scales. As the performance of AFM depends greatly on the properties of the cantilevers, many works have been carried out to improve cantilevers by means of modifying their geometries via lithography [1] and ion beam milling [2,3] that primarily involve opening areas on the cantilever's face, resulting in high resonant frequency, low spring constant, and low hydrodynamic damping. Similar improvements were achieved using a hollow beam cantilever with nanoscale wall thickness [4]. In fact, the combination of these two approaches (in-plane opening and hollow beam) can result in unique metamaterial structures with tunable properties [5], but it has not been explored for AFM application. In this work, we explore hollow AFM cantilevers with in-plane modifications. We accomplish this by (1) taking a commercial solid silicon cantilever, (2) making a different number of holes on the face using pulsed laser micromachining, and (3) coating it with alumina using atomic layer deposition and etching the internal silicon which results in a hollow probe with holes. We present the effects of these modifications on the cantilever's resonant frequency, quality factor, and spring constant in air. This work provides an insight into strategies for tuning a cantilever's properties for both flexural and torsional modes.

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