SOURCES OF STRESS GRADIENTS IN ELECTRODEPOSITED Ni MEMS

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The ability of future integrated metal - semiconductor micro-systems such as RF-MEMS to perform highly complex functions will depend on developing freestanding metal structures that offer improved conductivity and reflectivity over polysilicon structures. For example, metal-based RF MEMS technology could replace the bulky RF system presently used in communications, navigation, and avionics systems[1]. However, stress gradients that induce warpage of active components have prevented the implementation of this technology[2,3]. Figure 1, is an interference micrograph image of a series of cantilever beams fabricated from electrodeposited Ni. The curvature in the beams was the result of stress gradients intrinsic to the electrodeposition process. To study the sources of the stress in electrodeposition of Ni we have incorporated a wafer curvature based stress sensor, the multi-beam optical stress sensor[4], into an electrodeposition cell.

We have determined that there are two regions of stress induced by electrodepositing Ni from a sulfamate-based bath (Fig 2). The stress evolution during the first region, 0-1000Å, was determined to be dependent only on the substrate material (Au vs. Cu), whereas the stress evolution during the second region, >1000Å, was highly dependent on the deposition conditions. In this region, the stress varied from +0.5 GPa to –0.5GPa, depending solely on the deposition rate. We examined four likely sources for the compressive intrinsic stress, i.e. reduction in tensile stress, and determined that only the adatom diffusion into grain boundaries model of Sheldon, *et al.* [5] could account for the observed compressive stress. In the presentation, we shall discuss the compressive stress generation mechanisms considered and the ramifications of these results on fabrication of electrodeposited Ni for MEMS applications.

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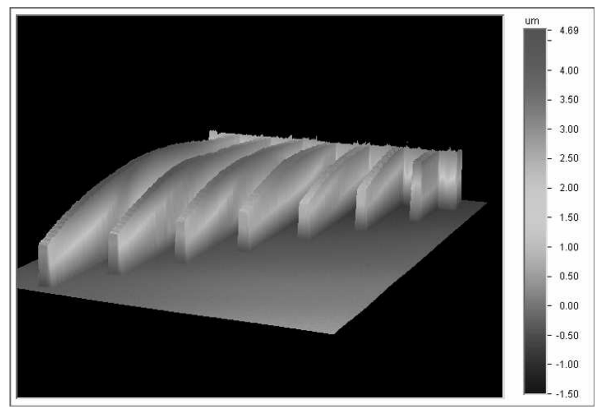

Fig. 1 - Interference microscope images of Ni cantilevers that show bending into the substrate.

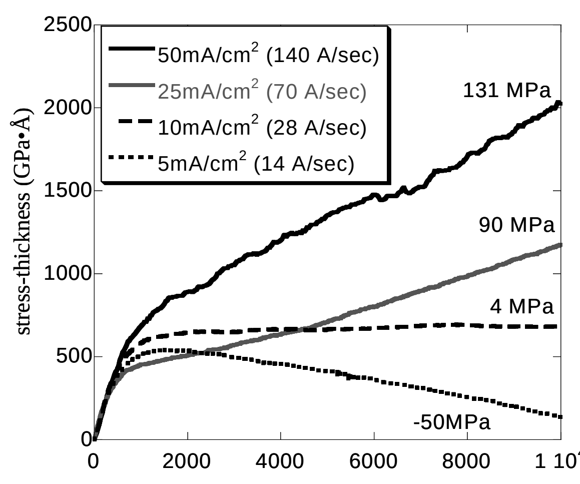

Fig. 2 - Stress*thickness vs. thickness for Ni electroplated from sulfamate bath as a function of plating rate.

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