Guest Editorial

Surface Micromachining

Arguably, the inception of surface micromachining occurred over 40 years ago, at nearly the same time as the introduction of the integrated circuit. Nathanson and colleagues at Westinghouse Research Laboratory combined a simple resonating cantilever beam with an early electronic transistor to produce a complete oscillator on a silicon wafer. The process included the same photolithographic techniques and thin film deposition that were being used to construct the transistor. However, rather than a fixed transistor gate, a freestanding metal cantilever beam was created by dissolving the silicon dioxide from beneath the metal gate. The cantilever, free to vibrate at its resonance, electrostatically interacted with the gate region producing a feedback signal to the circuitry completing an oscillator on a chip.

However, to most of us, it was not until polycrystalline silicon, or simply polysilicon, was introduced in the 1980s as the mechanical material for microstructures, that the concept of surface micromachining started to hit home as a promising new technology. Significant strides made during that decade provided an understanding of the processes necessary to produce an acceptable mechanical material rather than simply an electrical material for integrated circuitry. Dissolving sacrificial layers, such as the oxide film, to release thin-film microstructures defined surface micromachining.

Today, it is readily accepted that other material systems such as metals/organics, dielectrics/polysilicon, polysilicon-germanium/polygermanium, or silicon carbide/silicon also define surface micromachining. These systems offer unique or highly desirable materials characteristics enhancing the general art of surface micromachining. The principal differentiation of surface micromachining from other micromachining fabrication techniques can be dually stated as having: (1) a high degree of overlap with existing CMOS fabrication equipment and processes; and (2) the ability to build highly sophisticated mechanical devices comprised of functional elements with flexures, rubbing surfaces, and interlocking surfaces.

Undoubtedly, designing PSM MEMS is very different from the process of designing conventional macroscopic mechanical devices. Since the basis is photolithographic transfer of the design onto a planar substrate, the process is two-dimensional in nature. A designer creates a series of 2-D drawings that can be extended to multiple layers and combined unique process steps to create intricate, fully 3-D structures. Typically, surface microstructures have lateral dimensions 1 μm to 1 mm, with thickness 0.1 to 10 μm, and are offset 0.1 to 2 μm from the substrate.

For this special issue, we received a number of excellent manuscripts that covered areas broader than the classical definition of surface micromachining. We chose to loosen the definition of surface micromachining in order to include several of those manuscripts. We appreciate the tremendous amount of work that the authors have put into the preparation of these manuscripts and we extend our thanks to them for sharing their work with this community. Likewise, we are indebted to SPIE for the opportunity to publish and make these manuscripts available. We hope that you find the contents of this issue of interest and that you fully enjoy the result!

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