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Plenty of Opportunity as well as 'Room at the Bottom' –
Some Examples in Optical MEMS

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Abstract: More than a quarter century has passed since attention began to focus on MEMS with its fulfillment of the promise of "Plenty of Room at the Bottom," as had been foreseen a half century ago by famous physicist Richard Feynman. The promised '***room***' held plenty of challenges as well as plenty of opportunities. I present some reflections on these early years of MEMS and then discuss results obtained from our research at BSAC on optical MEMS. These results confirm my belief in major opportunities for advancement in the optics area for MEMS. While much earlier research in optical MEMS has exploited the use of micromirrors, we have concentrated efforts on incorporating other optical devices. Components other than activated mirrors must be available to produce micro-optical systems for many applications that have established their value in macro designs. Chief among the needed components are high-quality microlenses that can be accurately formed and placed at specified locations in the fabrication of an optical micro system. The first part of this talk discusses our application of microlenses to wavefront-sensing for use in adaptive optics. I describe a microlens array in which the passage of light through a specific lens can be identified by a new mechanical-frequency-based selection scheme. A lens array is typically part of a Shack-Hartmann (SH) sensor for measuring wavefront aberration, a necessary input for adaptive-optic systems. We show that a MEMS design for the lens array can markedly improve SH performance by increasing the dynamic range of measureable wavefront aberrations. The second part of my presentation describes a new, highly reliable and yet comparatively simple fabrication method that we have developed to produce robust microactuators for scanners and device positioning. I describe the application of an example of these microscanners to ocular surgery using laser ablation of tissue. Our results with this newly designed MEMS microscanner compare very favorably to those achieved using a conventional commercial laser-ablation system. As a final topic illustrating our optical MEMS research, I present initial results obtained using a new high-speed MEMS-based phase-shifting interferometer. I hope to leave you convinced, as am I, that opportunities for fruitful applications are extremely widespread in optical MEMS.