II-08

Deep x-ray lithography for micromechanics and precision engineering applications

Henry Guckel
University of Wisconsin-Madison, Department of Electrical and Computer Engineering, 1415 Engineering Drive, Madison, WI 53706

Micromechanics, an emerging technology for sensor and actuator fabrication, has a large market potential that has already been exploited for sensors. Progress in actuators has been more modest because necessary fabrication tools have been unavailable. Tools based on photoresist technology require very large structure heights (millimeters) for mask-defined prismatic photoresist shapes with flanks that differ from 90 degrees by less than 15 arc-seconds. Such photoresist procedures differ from their counterparts in the microlectronics industry. Thus, application is based on precast sheets of poly methyl methacrylate (PMMA) and solvent bonding followed by precision fly-cutting. Exposure is based on well-collimated x-ray sources, synchrotrons, with flux densities that can deposit 1600 J/cm^3 in a finite time at the correct photoresist depth. Since PMMA has an absorption length that varies with photon energy (100 μm at 3000 eV; 1 cm at 20,000 eV), beamline and exposure designs center on transmission filters that control the low-energy portion of the x-ray spectrum. Since exposure latitude is large (a factor of 15 is acceptable), beamline and exposure design are relatively simple. Experiments at Aladdin and the NSLS examine the effectiveness of manufacturing with synchrotron radiation. Actuator test vehicles are linear and rotational magnetic micromotors with force outputs in the mN range. Large parts with submicron precision produced through x-ray assisted processing are used in ink jet printing and precision injection molding.