

Deep X-Ray Exposure System with Multistage for 3-D Microfabrication

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Abstract

This paper reported a new deep X-ray exposure system with multi stage, which can fabricate free shaped 3D microstructures with controllable inclined, curved and stairstepping wall on planar and nonplanar surfaces. Based on a compact synchrotron light source, a dedicated X-ray beamline and the exposure device had been constructed. They could work in the exposure environments of vacuum or helium gas. The exposure device was mainly made up of 5 stages and had as many as 6 degree of freedoms, which enabled the system to own complicated exposure functions. Besides the scan in its plan, the substrate surface could also rotate round one of its normal and tangent respectively. Driven by a PZT stage, the X-ray mask could move freely in its plan against the substrate behind, which were used to control the wall inclination and flexure of the substrate structure. The system also had the off-line mask-substrate alignment function. Various 3D PMMA microstructures can be realized by the system, such as lens array, micro screw, nozzles, tube connector, conical tubes, inclined channels, long circle channels, angle pipe with smooth joint, cone, gear rack, long column with curve cross-section etc., which are impossible for the normal X-ray lithography system. A series of deep X-ray lithography experiments have been completed and obtained some interesting 3D PMMA microstructures. It demonstrated the potentiality of the system, which will greatly enlarged the application fields of deep x-ray lithography and LIGA process