

# Study on Fabrication of High Aspect Ratio Electrostatic Micro Actuators Using LIGA Process

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## Abstract

The fabrication of high-power electrostatic microactuators by the LIGA process has been investigated. Advantages of electrostatic microactuators fabricated by the LIGA process are discussed. The basic structure of the microactuators was composed of movable and fixed electrodes of Ni, an isolation layer of SiO<sub>2</sub> and a Si substrate, which was fabricated by one mask process. As design rules, a minimum resist width of 2 μm, resist height of 120 μm, maximum width of movable parts of 10 μm, minimum width of fixed parts of 40 μm and driving voltage of about 100 V, were decided. A 120 μm-thick PMMA resist was formed on a Si substrate by a casting method. The PMMA was exposed using a compact SR source "AURORA", using an X-ray mask with 7 μm-thick Au absorber on a 2 μm-thick poly-Si membrane. The exposed PMMA was developed by GG developer. Ni microstructures with 100 μm-height, 2 μm-minimum width, maximum aspect ratio of 50, 2 μm-minimum gap were made by electroforming. The average surface roughness of the PMMA microstructure's sidewall and Ni microstructure's sidewall were 9.4 nm and 23.1 nm, respectively. Ni microstructures used for movable electrodes were separated from the substrate by lateral etching of SiO<sub>2</sub>.

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