Micrometer-scale photo direct machining of polydimethylsiloxane using laser plasma EUV radiations

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Abstracts: *We have investigated micromachining of PDMS sheets using laser plasma EUV radiations. We found that submicrometer structures can be fabricated by direct EUV irradiation through contact masks. X-ray photoelectron spectroscopy has revealed that there is no chemical modification induced by the EUV irradiation. All these properties are suitable for micromachining of PDMS elastomers at high aspect ratios*

Polydimethylsiloxane (PDMS) is a material used for micro total analysis systems / lab-on-chips due to its flexibility, chemical / thermo-dynamic stability, bio-compatibility and mold ability. For further development, it is inevitable to develop a technique to fabricate three dimensional structures in micrometer-scale at high aspect ratio. In the present work, we have investigated a technique for micromachining of PDMS by means of photo direct machining using laser plasma EUV light. Figure 3 shows the experimental setup for the EUV micromachining. The EUV radiations were generated by irradiation of Ta with Nd:YAG (10 ns) light. The generated EUV light around 100 eV (10 nm) were focused on PDMS surfaces at power densities up to 1×10^{8} W/cm^{2}, using an ellipsoidal mirror. Contact masks were placed on top of PDMS sheets to fabricate designed microstructures. Figure 1 shows fabricated square holes. It is remarkable that the edge have steep walls as shown by Fig. 2. We found that ablation depth is governed by power density of EUV light on PDMS surfaces. At power densities sufficiently higher than the threshold, the surfaces are ablated at a rate up to 200 nm/shot. X-ray photoelectron spectroscopy has revealed that there is no chemical modification induced by the EUV irradiation. All these properties are suitable for micromachining of PDMS elastomers at high aspect ratios.

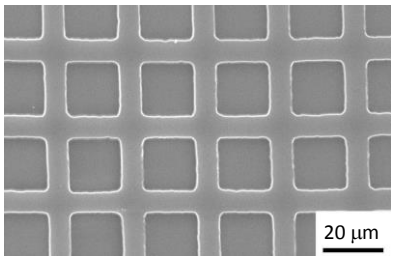

Figure 2: SEM image of microstructures fabricated by EUV irradiation on a PDMS sheet.

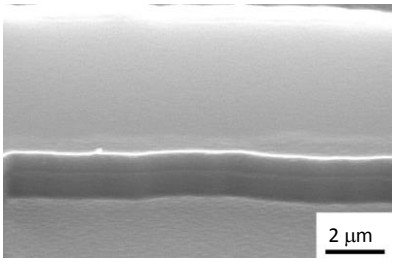

Figure 3: SEM image of edge of the structure observed at 45°.

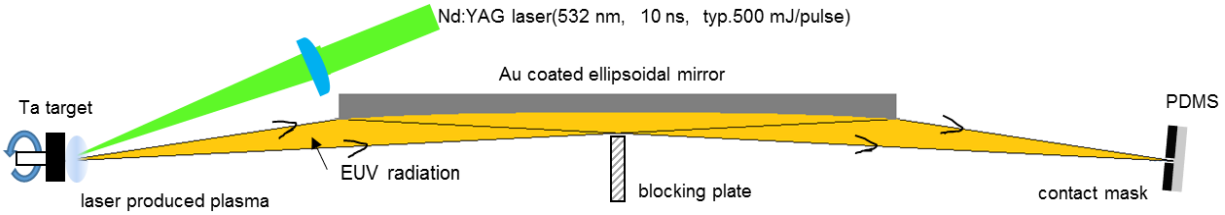

Figure 1: Experimental set up for EUV irradiation.