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Proton beam lithography in a new, liquid phase negative resist material

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To extend the applications of the proton beam writing (PBW) technique it is important to explore potential new resists materials. Poly(dimethyl-siloxane) (PDMS) is a promising material for many applications nowadays because of its advantageous properties. In cross-linked, elastomeric form it has been widely used to fabricate Micro-Electro-Mechanical Systems (MEMS), microfluidic devices, micro-stamps by moulding techniques [1,2], or in micro optical devices using developer-less PBW method [3]. However, the PDMS can also be crosslinked directly induced by ion beam irradiation [4].
In this work we investigated the applicability of liquid PDMS polymer as a negative resist material for direct proton beam writing technique. We irradiated the polymer in liquid phase, spin-coated on different substrate materials creating various microstructures. PDMS pre-polymer was crosslinked just by PBW. As the crosslinking process increases, the irradiated area becomes more solid. The rate of the solidification strongly depends on the deposited ion dose. The effects of fluence, beam current, substrate type and developer solvent was investigated. Furthermore, at the irradiated areas the adhesion, the wettability and the rigidity also changes due to the chemical change of the PDMS polymer. This effect makes the possibility to form microstructures in PDMS with tunable adhesion and wettability properties. In practical viewpoint, the PDMS resist can also have some advantages compared to other resists such as easy stripping, very fast developing (as the un-crosslinked PDMS is soluble in many organic solvents), not sensitive to light or high current.

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