Self-aligned single exposure deep x-ray lithography

V.Nazmov1,2, B.Goldenberg1, E.Reznikova1
1Budker Institute of Nuclear Physics of SB RAS, 630090 Novosibirsk, Russia
2Institute of solid state chemistry and mechanochemistry of SB RAS, 630128 Novosibirsk, Russia
E-mail: V.P.Nazmov@inp.nsk.su

Microdevices are usually made up of several interacting components that can be assembled on the basis of 3-dimensional LIGA structures, using various techniques to fulfill the required positioning accuracy - the so-called combined LIGA technology [1]. As a part of the LIGA technology, deep X-ray lithography enables the formation of 3-D microstructures of significant size in each of the three dimensions; however, it is often possible to improve positioning accuracy by using self-alignment technique when patterning with the use of X-ray mask, as shown in [2]. In our work, we consider single-exposure with self-alignment technique for the creation of microdevices of technological material, which can demonstrate new physical capabilities.

I. Self-aligned expose from planar side

Exposure scheme X-rays, including stepped attenuator

Measured IR-spectra of exposed SU-8 for different SR doses: increased peaks between 1091 nm and 1150 nm correspond more crosslinks into a polymer chain with the dose increase

II. Self-aligned exposure from backside

Exposure scheme X-rays, including stepped attenuator

N_{1,2,3} - refractive microstructures number; \delta - refractive index decrement

N_{1,2,3} = N_{1} \delta(E_{1}) = N_{2} \delta(E_{2}) = N_{3} \delta(E_{3})

Three X-ray lens, aligned into one lens, for three photon energies at the same focal distance

X-ray focus scheme containing its own sub-focus for each photon energy

III. Self-aligned exposure by means of splitting primary X-ray beam

Exposure scheme with splitting the initial X-ray beam

8 mm thick SU-8 layer successfully treated by deep X-ray lithography

Acknowledgement

The part relating to microstructuring was performed at the shared Siberian Synchrotron and Terahertz Radiation Center (CU SSTRC) on the basis of the VEPP-4 - VEPP-2000 complex at BINP SB RAS, using equipment supported by the Ministry of Education and Science of the Russian Federation project Number RFMEFI62119X0022.

This work was also supported in part by the Ministry of Education and Science of the Russian Federation Grant Number 0237-2019-0001.

Conclusion

We have presented the further development of the deep X-ray lithography technique in terms of the formation of combined microstructures with a high aspect ratio. Dose variation through the use of attenuators of various thicknesses and the splitting of the X-ray beam can give new properties to the formed microstructures.

Literature