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Optimization of novolak-based photoresists for ion beam planarization of aluminium mirrors

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Technical aluminium alloy materials as AL6061 or AL905 are widely used in fabrication of high performance mirror devices. The surface error topography after common manufacturing by single-point diamond turning meets the requirements for applications in the infrared spectral range. However, for short-wavelength applications in the visible and UV spectral range the demands on the optical surface quality increase immensely. To use the aluminum mirrors in the short-wavelength, i.e. visible and UV, spectral range, one technological solution is the coating of the Al optics with an amorphous nickel-phosphorous (NiP) layer and a metallization layer on top to realize ultra-smooth, highly reflective surfaces. The reduction of the surface roughness of aluminum optics without use of a NiP coating and accompanying the simplification of this process chain is preferable.
Ion beam planarization processes are a promising technology to transfer the ultra-smooth surface of a planarization layer into the underlying aluminum substrate. Novolak-based photoresists, which are commonly used in the semiconductor industry, were deposited on the single-point diamond turned aluminium mirrors by spin coating to compensate differences in height. By reactive ion beam processing, the ultra-smooth surface topography of the photoresist is transferred into the substrate. One important parameter which affects the transfer process significantly is the selectivity, the ratio of the etching rate of the underlying substrate to the etching rate of the planarization layer. An approximation of a selectivity of 1:1, that implies equal etch rates for planarization layer and aluminium substrate, is prerequisite for the transfer process. Thermal pre-treatment of the planarization layer and different operating gases affect the properties of the resist during the etch process and the selectivity significantly.

Keywords
Ion beam planarization
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