LASER POLISHING OF PLASTIC MICRO-OPTICS

Task

Plastic optics are often produced by injection molding or, less frequently, by mechanical turning or milling, but these processes are not suitable for producing single pieces or individual optics. Thus, a flexible process is necessary for the individualized manufacture of micro-optics made of plastic. This is particularly interesting in medical technology, e.g. for intraocular lenses or contact lenses, in order to manufacture patient-specific products. In this context, laser-based shaping processes, e.g. ablation by ultrashort pulse radiation (USP radiation), can be convincing thanks to their largely geometry-independent processing and high precision. However, in order to use this manufacturing process for micro-optics production, the surface topography must be polished afterwards.

Method

Thermoplastics can be polished with the laser polishing process by remelting the material near the surface. Since surfaces processed with USP usually have very good shape accuracy, but a high micro-roughness, polishing without changing the geometry is necessary. The surface is heated up to just above the softening point over the entire surface using CO_2 laser radiation. High-frequency roughness is smoothed by the surface tension. Due to short interaction times, the thermal influence on the overall optics is kept as low as possible to avoid distortions to the geometry. The interaction time is usually less than one second. This is repeated several times, whereby the micro-roughness is reduced in each iteration step, until the roughness corresponds to optical quality.

Results

The geometry of a plastic optic with a diameter of a few millimeters can be produced by ablation with USP radiation having a vertical resolution of 1 µm. The surface roughness in a 1 x 1 mm² measuring field is then approximately Sa ≈ 0.4 µm, which corresponds to an opaque surface. This roughness can be reduced to Sa < 10 nm by laser polishing.

Applications

The demand for products customized to an individual patient is growing, particularly in medical technology. The process presented here can be used, for example, to manufacture intraocular lenses or contact lenses.

Contact

Karsten Braun M. Sc.
Telephone +49 241 8906-645
karsten.braun@ilt.fraunhofer.de

Dr. Edgar Willenborg
Telephone +49 241 8906-213
edgar.willenborg@ilt.fraunhofer.de

3 Microstructured (left) and laser polished (right) intraocular lens.