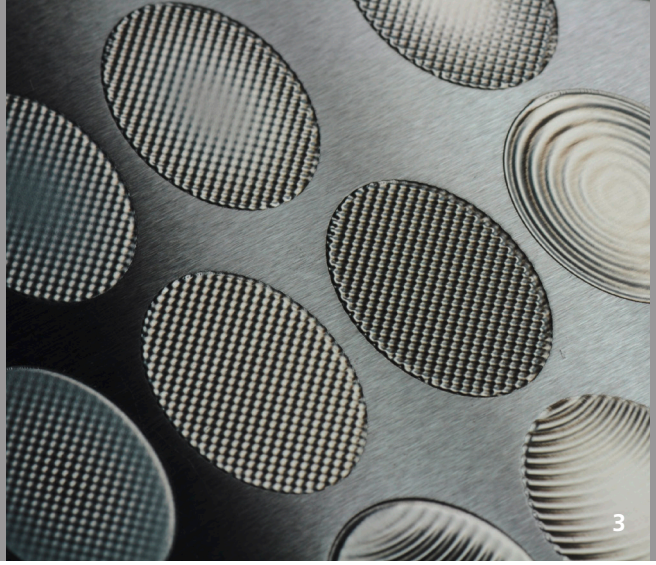

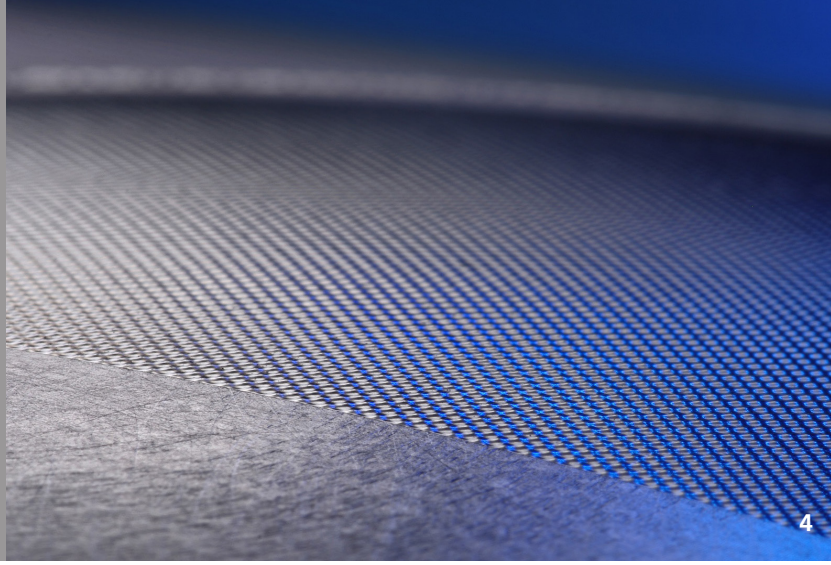

WAVESHAPE PROCESS FOR LIGHT GUIDE TOOLS

Task

Light guides for guiding and shaping LED light are often manufactured by means of plastic injection molding. On the one hand, the surfaces of the molds used for this purpose must be polished so that the light can be guided by total reflection with as little scattering and, thus, as little loss as possible. On the other hand, decoupling structures are used locally to distribute the point-shaped LED light in the light guides, which distribute the light specifically in a linear or planar manner. One application for these guides can be found in the automotive industry, where increasingly complex designs are required for ambient lighting. Together with Prof. Bordatchev from the National Research Council of Canada (NRC), Fraunhofer ILT researchers have investigated whether the Waveshape process developed at the institute is suitable for creating efficient outcoupling structures for light guides.

Method

Based on optical ray tracing simulations of the NRC, wave structures of different structural wavelengths (around 500 µm) and heights (50 - 150 µm peak to valley) were generated at Fraunhofer ILT. The institute used surface structuring by laser remelting (Waveshape) to structure the surface of the tool steel 1.2343, commonly used for plastic injection molds. The area rate was 0.5 to 0.125 cm²/min, depending on the structure height. The main advantage of the Waveshape process is that the structures have a polished surface, meaning that optical behavior of the structures results only from their geometry and not from scattering effects from their surface roughness. Thus, the optical effect can be easily calculated.

The surfaces created in this way were subsequently molded in transparent plastic; then the institute examined if they could distribute light irradiated at the short edge homogeneously and over a wide area.

Results

The structures produced have a low manufacturing tolerance (< 10 percent in the structure height) and low roughnesses (Sa 0.2 µm), as required for practical optical applications. The scattering pattern agrees well with the simulations and is already mostly homogeneous in this first experiment without any optimization.

Applications

The results show that the Waveshape process is suitable for manufacturing outcoupling structures in tools for light guides. Possible applications are wherever concentrated LED light is to be distributed in a linear or planar manner.

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3 Wave and nap structures created with Waveshape.

4 Burled structure on curved surface.