Diamond turning of the sub-wavelength structured freeform optical surface

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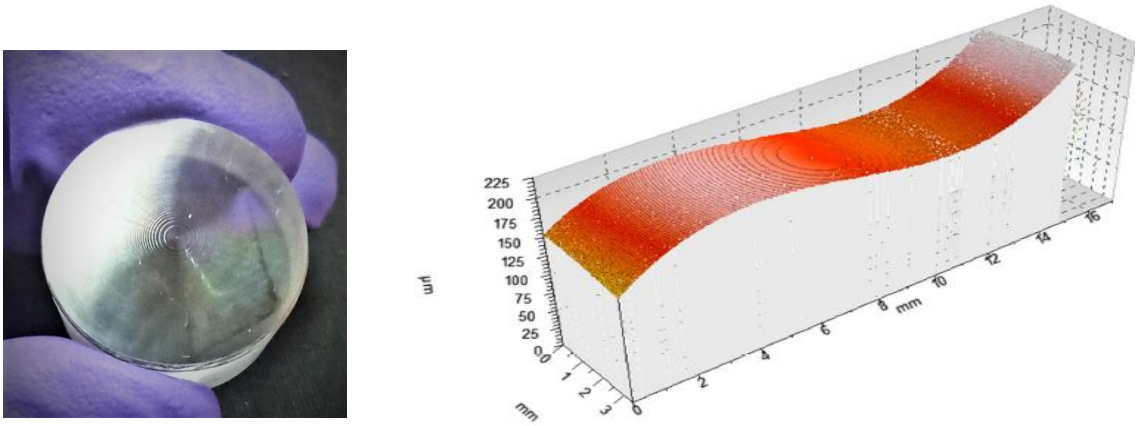
Abstract

The combination of freeform shapes with sub-wavelength structures offers significant advantages in applications such as hyperspectral imaging, beam shaping, wavefront coding, and spectroscopy. The use of these optical surfaces offers improved functionality with minimum system volume. The sub-wavelength structured freeform surfaces are the most complicated and most demanding surfaces for the above applications due to the dual advantages of the freeform base profile and diffractive structures. Owing to the encouraging and immense applications of sub-wavelength structured freeform surfaces a variety of manufacturing approaches e.g.structured tool-tip, fly cutting, fast tool servo, and lithography techniques are developed recently. However, the challenge in fabrication and metrology feedback of these surfaces are the limiting factor.

In this work, the slow tool servo(STS) configuration of diamond turning is explored to generate the sub-wavelength(for 600nm wavelength) structures over the base cubic freeform shape. In the first step, fiducial aided- base cubic shape is generated by an optimized STS machining process. After that, the multilayer tool-path is generated for machining of cubic shape and sub-wavelength structures simultaneously. Various aspects of tool path generation i.e. definition points, nose radius, motion error are studied. The detailed characterization of base cubic shape and structures is performed on the optical profiler. The structures are fabricated with a fabrication error of less than 10%. The fabricated component is shown in Fig.1. The detailed analysis of the error map and feedback process for corrective will be discussed in the conference presentation.



(a) (b)

Fig. 1: (a) Fabricated structured freeform surface (b) Measured surface profile