

Fabrication of Micro-Optical Devices Using Slow Tool Servo Diamond Turning Process

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Micro-optical devices, e.g., micro lenses, micro mirrors, play an important role in high speed data, voice and video signal transmissions. In this study, a new method of fabricating micro optical devices was investigated. The method is different from traditional fabrication processes in the sense that the micro optical elements were simultaneously machined in a process known as slow tool servo (STS) machining.

In optical industry, freeform optical surfaces are now becoming a practical solution for some design and manufacturing problems. Even though each individual optic in a lens array can be an axisymmetric surface, multiple optics arranged in a matrix format need to be treated as a freeform surface and therefore fabrication methods for freeform surfaces can be exploited to fabricate the array. The selected micro lens array was fabricated on a Moore Nanotechnology 350 FG ultraprecision diamond turning machine using STS process. This is a report of one approach to freeform fabrication, with potential applications in many other disciplines.

Specifically, a 100x100 micro lens array mold was fabricated using an ultraprecision diamond turning machine equipped with four independent axes. Unlike the conventional process where a single diamond tool is used to machine each individual lens at a time, this research demonstrates the development of an innovative diamond tool trajectory which allows the entire microlens array to be machined in a single operation. The machine lens array mold is then used to mold plastic and/or glass lens arrays. The machined microlens array was measured for both surface geometry and surface roughness. This paper describes in detail this unique process from optical measurement, machining process development to final results. This research also demonstrates the possibility of fabricating many arbitrary shapes using the same approach.