Efficient and Rapid Freeform Optics Manufacturing Process

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Freeform optics has received great interest for various future optical system applications such as head mounted displays, highly compact camera systems, asymmetric solar energy concentrators and segmented extremely large telescopes. While it opens up a fascinating optical design and performance optimization space, the manufacturing of freeform optics has been a critical and practical limitation preventing its wide and general application. The rapid and efficient freeform optics manufacturing process has been investigated and developed through two innovations, metrology and fabrication technology. A high dynamic range deflectometry system guides freeform optics fabrication steps by providing residual surface error information during the iterative grinding and polishing phase. The metrology system provides sufficient bandwidth in terms of tracking the error in the spatial frequency distribution, which is essential to meet a required surface smoothness requirement in the final optics. The surface fabrication process has been developed in a way that leverages the high spatial resolution content of the surface measurement in both the run optimization and actual fabrication processes. This deterministic and systematic process has been increased the overall manufacturing efficiency dramatically, which saves significant amount of manufacturing related resources including machine run time, optics shop maintenance, human resources, mechanical/chemical polishing materials, and the overall cost.

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