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Ultraprecision Optics Fabrication and Characterization

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This special section covers a wide range of advanced high-precision optical manufacturing technologies that push the limits for fabricating optical components as well as tailored characterization techniques to analyze imperfections, to develop, to improve, and to control processes and target specifications.

A main focus is on fabrication and characterization of optical components over the entire spectrum of surface errors and imperfections covering the low-to-mid-to-high spatial frequencies as well as on links to the optical performance covering image quality, point spread function, and bidirectional reflectance distribution function.

Cutting-edge applications with innovative optical designs not only require new fabrication and metrology technologies but also need a coherent view of the relationships between the different process steps as well as pragmatic approaches to provide optical surfaces with tailored specifications for a specific application. This special section especially concentrates on the comprehensive subjects, topics, and interlocking technologies for ultraprecision optics fabrication and characterization.

The thirteen articles in this special section cover a nice balance of the latest findings and developments for the wide spectrum of topics discussed above. More specifically, this issue includes: (1) novel metrologies and techniques to better measure freeform surfaces such as using the double digital fringe projection method (Uribe-Lopez et al.) and new metrological multispherical freeform artifacts (Fortmeier et al.); (2) novel metrologies and techniques to measure defects such as using modulated dark field to detect particles (Choi et al.) and a robotic light scattering sensor technique to assess roughness and defects on freeform optics (Herffurth et al.); (3) new advanced fabrication methods including micro-laser-assisted diamond turning to increase substrate ductility and enhance diamond tooling lifetime (Shahinian et al.), interference technique to fabricate two-dimensional diffraction scale gratings (Shimizu et al.), reactive ion beam etching technology for a fabrication of transmission grating (Finzel et al.),

ion beam technology for metal optics finishing (Bauer et al.), additive manufacturing process of aluminum silicon alloy mirror (Hilpert et al.), and a fiber-based polishing tool for a deterministic fabrication (Shahinian and Mullany); and finally (4) advancements in optical fabrication processing including new methods to estimate subsurface damage depth during grinding processes for various workpiece materials and grinding process variables (Suratwala et al.), pseudo-random tool stroke to reduce workpiece surface roughness (Guo et al.), and adding more determinism to subaperture polishing by accounting for changes in the skew tool influence function (Feng and Cheng).

Dae Wook Kim is an assistant professor of optical sciences and astronomy at the University of Arizona. His main research area covers precision freeform optics fabrication and various metrology topics. He is a chair of the Optical Manufacturing and Testing (SPIE), Optical Fabrication and Testing (OSA), and Astronomical Optics: Design, Manufacture, and Test of Space and Ground Systems (SPIE) conferences. He is a lifetime and senior member of OSA and SPIE. He has been serving as an associate editor for the journal *Optics Express*.

Tayyab Suratwala is the program director for Optics and Materials Science and Technology (OMST) at Lawrence Livermore National Laboratory (LLNL). He received his BS degree in ceramic engineering from the University of Illinois at Urbana-Champaign in 1992 and his PhD in materials science and engineering from the University of Arizona in 1996. He has more than 90 peer-reviewed publications, including six patents/patent applications, four R&D100 awards, and a book titled *Materials Science & Technology of Optical Fabrication*. He is a fellow of the Optical Society of America.

Sven Schröder is head of the Surface and Thin Film Characterization Group in the Optical Systems Department of the Fraunhofer Institute for Applied Optics and Precision Engineering (IOF) in Jena, Germany. He graduated in physics in 2004 and received his PhD in 2008 from the Friedrich Schiller University (FSU) in Jena, Germany. His interests are directed to the study of roughness, light scattering, and functional properties of surfaces and coatings. He has authored and coauthored more than 100 articles and book chapters, and cochairs several EOS and SPIE conferences on the subject. He is also working on standardization projects within DIN and ISO.