Editorial

Michael M. Pfeffer*

Aspheric optics: from design to manufacturing and aspheric metrology

DOI 10.1515/aot-2016-0038

Today, aspheric elements are not only used in high-end applications such as lithography, astronomy, and space-borne optical devices. They are also widely utilized in industrial optical devices such as sensors, machine-vision systems, and even consumer-optical products. However, although aspheric technology is becoming more and more accepted and implemented, there is still a lot that needs to be learned and done in order to exhaust its full potential. Therefore, we decided to dedicate this issue of *AOT* to aspheric technology: from design to manufacturing and metrology.

Since the very early days of optics for astronomy and microscopy, it has become clear that, in principle, spherical optics will not be able to satisfy the requirements for high quality images. This explains why, in order to overcome spherical aberrations, optical designers have been trying since the 17th century to convince manufacturers to produce well-defined aspheric surfaces with sufficiently high surface quality.

Consequently, when dealing with aspheric technology, one has to consider three basic aspects that are all interrelated: optical design, manufacturing technology, and metrology.

At the beginning of the 20th century, a lot of effort was put into the design of lenses and the theoretical aspects. However, it was not until 1956 that Elgeet Optical (Rochester, NY, USA) came out with the first commercial, mass-produced aspheric lens element.

In the 1990s, because of the introduction of the World Wide Web, new microprocessors required new manufacturing processes for semiconductors and, consequently, new lens designs for lithographic lenses. The complexity of these lens designs then gave rise to the development of new aspheric manufacturing processes such as magneto-rheological finishing (MRF), fluid-jet polishing, computer-controlled polishing (CCP), and more recently ion beam finishing and laser beam ablation, and polishing. Here, the review article by Kiontke et al. gives an insight into today's boundary conditions for aspheric lens design, the description of surface shape, surface quality, and the corresponding manufacturing issues.

However, the quality of each manufacturing process – no matter whether it relates to the aspheric surface shape or the surface quality – can only be determined by a corresponding metrology. Therefore, metrology is one of the most critical issues in aspheric manufacturing technology. The review article by Beutler gives a comprehensive overview of contemporary metrology for the production process of aspheric lenses, including both their pros and cons.

The future technological path of aspheric technology will certainly lead to freeform shapes, which give rise to even more freedom by being tailored to one's optical surface and wavefront. The issues arising from these will be similar to those mentioned above; however, they are even more critical here, and the optical design, manufacturing, and metrology must be considered accordingly.

As an example that demonstrates this relationship between optical design, manufacturing, and metrology, Arasa et al. present a novel approach by describing local refractive index variations of plastic optical elements by means of freeform shapes.

Finally, I would like to thank the guest editors, Sven Kiontke (asphericon GmbH, Jena, Germany) and Santiago Royo (Universitat Politècnica de Catalunya, Barcelona, Spain) and their teams, for their constant engagement with this issue of *AOT*.

***Corresponding author: Michael M. Pfeffer,** Hochschule Ravensburg-Weingarten – Optical Systems Engineering, Doggenriedstrasse, Weingarten 88250, Germany, e-mail: pfeffer@hs-weingarten.de

Michael M. Pfeffer
Hochschule Ravensburg-Weingarten – Optical Systems Engineering
Doggenriedstrasse, Weingarten 88250
Germany
pfeffer@hs-weingarten.de

Michael Pfeffer graduated in 1998 from the Institute of Applied Optics at EPFL (Switzerland), obtaining his PhD for a thesis in the field of Optical Nanotechnology. In 2002, after several years working in the Swiss optics industry, he was appointed Full Professor of Optics and Engineering in the Department of Physical Engineering of Hochschule Ravensburg-Weingarten, University of Applied Sciences (Germany).
Dr. Pfeffer teaches and researches in the fields of optics, physical instrument design and nanotechnology. Currently, he serves as Vice-Rector for Research and International Relations. In 2005, the General Membership Meeting elected him to the Executive Board and CEO for the DGaO-Annual Meeting 2006. From 2008 to 2012 he served as President of the German Society of applied Optics (DGaO). In 2012 he was elected as Secretary of the Board of the European Optical Society (EOS). Dr. Pfeffer is member of the German Physical Society (DPG), the German Society of Engineers (VDI), and the Standards Committee Precision Engineering and Optics of the German Institute of Standardization (DIN).