Editorial

Stefan Bäumer* and Allen Yi

Topical issue on plastic optics

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Optics is a truly enabling technology of the 21st century. Looking around us, there are many devices in our daily lives, which we use to share our experiences, gain knowledge, or explore virtual worlds: smart phones with their cameras, tablets, computers with their cameras and screens and virtual or augmented reality glasses are increasing in ever larger numbers. There are also many optics based sensors which make our lives safer or just easier – think of cameras with various functions in a car: from lane assistance to parking aids or of the many security cameras helping in preventing crime.

And as solid state lighting gains increasing importance, beam shaping optics are needed to direct the light precisely into the direction we want. The internet of things (IOT) will need 'ears and eyes'. There is a good possibility, that optical sensor systems will play a large role in enabling the IOT. All of these applications and many more that we can think of are in need of affordable optics with sufficient quality and availability in large volumes.

When these three criteria come together it is very likely that polymer optics will play an important role. The technology of injection molding optics has matured and can be regarded as a standard technology for the production of optical elements and systems. It is widely accepted in the market and discussions on the quality of plastic optics in general are not held anymore. It is only discussed, if plastic optics is fit for a certain application. Furthermore in most cases it is the method of choice for (large) volume production of optics and can be very cost effective. Plastic optics have come a long way!

What is ahead for plastic optics? Where are the new developments advancing the field?

***Corresponding author: Stefan Bäumer,** TNO – Optics, Stieltjesweg 1, Delft 2628 CK, The Netherlands, e-mail: stefan.baumer@tno.nl
Allen Yi: Industrial and Systems Engineering, The Ohio State University, 210 Baker Systems, 1971 Neil Ave, Columbus, OH 43210, USA

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Currently there is continuous process improvement. Since mold making by single point diamond turning has reached a high level of perfection, aberrations introduced by the process of injection molding have become increasingly important.

Having a stable process window enables cost effective production and therefore research on how to characterize and predict process influences and parameters is ongoing. The tutorial of Lars Dick et al. gives a good overview on state of the art process development. The article by Li-Ting Huang et al. is on wavefront measurements but in essence describes a method on how to distinguish process induced deviations such as birefringence and stress induced aberrations from surface deviations.

It evident as well, that metrology is still an area of research and development. The advantage of injection molded optics or plastic optics in general is that metrology features can be integrated in the design without additional cost. The article by Chih-Yu Huang et al. shows a good example of this practice.

Process development and metrology plastic optics and its manufacturing technology enable new products with freeform optical components. Freeform designs have already entered volume production mainly in the solid state lighting industry. However, by designing more and more integrated and higher performing optics freeforms will enter the standard toolbox of optical designers. The contribution of Fengzhou Fang et al. gives an overview on the current process chain that should be in place to manufacture freefrom optics, including mold making. The article by Allen Yi et al. shows another nice example of the possibilities that happen when using freefrom optics.

With injection molding more and more other processes become available for the production of optical systems. Designing and manufacturing an integrated sensor by hot embossing or lamination technology is described in the article of Maik Rahlves et al. The integrated design approach using multi-materials is also shown in the article.

An upcoming technology for manufacturing plastic optical components and systems is captured under the umbrella of 3D printing. 3D printing in all its different facets could become a new addition to the arsenal of manufacturing technologies for optical systems. The review by Andreas Heinrich and his group gives us a first glimpse on the possibilities of designing integrated optical systems based on 3D printing.

And finally the industry is always looking for improvements leading to cost reduction for the customer. Being able to directly diamond turn optical quality surfaces into steel can be one of these improvements. Roland Bohr reports on the progress of exactly that: direct diamond turning optical surfaces in steel.

A last important area of research and development is seamless computer aided design (CAD) transfer. For optical designs to be manufactured in an efficient way with the least amount of error possible, it is handy to translate a design file with sufficient accuracy into a standard for the exchange of product model data (STEP) file, which can be checked by a machine operator and a mechanical designer. From the STEP file a machine-file for the diamond turning machine can be generated. In many cases in this process chain several manual file translations or manipulations are performed. Automating the process chain could lead to fast and less error prone manufacturing. There is no article on this issue, however the editors feel that the topic should be addressed and are looking forward to future contributions.

Finally we would like to thank all the authors and co-authors for their contributions to this issue which gives us an update in the field of plastic optics. For the reader we wish you informative and pleasant reading.

Sincerely
Stefan Bäumer and Allen Yi.

Stefan Bäumer
TNO – Optics, Stieltjesweg 1, Delft 2628 CK
The Netherlands
stefan.baumer@tno.nl

Stefan Bäumer studied Physics in Germany and the USA. In 1988 he received his Master's of Science degree from Washington State University. He subsequently returned to Germany to receive his PhD in Physics at the Institute of Optics of the Technical University Berlin in 1995. Until 2012 Dr. Bäumer worked in several positions at Philips in Eindhoven, The Netherlands. Positions included optical designer at Philips Hightech Plastics and Senior Principal Engineer at Philips Lighting. Since 2012 Stefan Bäumer has worked at TNO in Delft, The Netherlands. His current position is as principal scientist in the optics department. His work focuses on optical systems design for high tech systems as well as for consumer optics.

Allen Yi
Industrial and Systems Engineering
The Ohio State University, 210 Baker Systems
1971 Neil Ave, Columbus, OH 43210, USA

Allen Yi received his PhD in Mechanical Engineering from Boston University in 1993. He subsequently joined Corning Precision Lens as a staff scientist. In 2002, Professor Yi joined Ohio State University. His research activities have been in the general area of precision engineering with a focus on high volume optical fabrication, freeform and microoptics fabrication as well as micromachining processes for medical and biomedical device fabrication. Professor Yi's current research interests include compression molding of glass optics and injection molding of high precision polymer optics.