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Editorial

Optomechanical engineering

This issue is dedicated to optomechanical engineering. So, let us first have a look at the definition: optomechanical engineering implies that there is some relation to optomechanics. However, when you try to find out the exact meaning of this expression, you are going to get confused. This is because there are at least two different definitions.

One was given in 2009 by F. Marquardt and S. Girvin and later also by T. Kippenberg et al., who defined optomechanics from a quantum-optical point of view. Mainly, they focus on the radiation pressure interaction between photons and matter using optical resonators. It is clear that these effects occur on very low energy scales and thus are of minor interest for most technical applications on a macroscopic level.

The second definition of optomechanics was given in 1993 by D. Vukobratovich, who defined optomechanics as the science, engineering, and/or art of maintaining the proper shapes and positions of the functional elements of an optical system so that the system performance requirements are satisfied.

Here, except light, all elements within optical systems have mass and mechanical properties. Therefore, in some way, applied optical engineering is always related to mechanical engineering. It just depends on the boundary conditions if you can accept or neglect influences such as gravity, mechanical loads, thermal changes, or ionizing radiation exposure. In any case, cutting-edge optical engineering, for example, objective lenses for lithography, cannot neglect mechanical influences and thus has to develop corresponding evaluation tools.

Although this appears to be evident, among scientists and optical engineers, there is little interest in the interdisciplinary field of optomechanics. Typically, physicists do not want to deal too much with mechanical issues, whereas mechanical engineers are not eager to discuss the optical aspects of a system to be developed. Moreover, apart from a few universities in the United States, there is practically no academic training in this domain. In Europe, among academic researchers, optomechanical engineering is rather unknown and it is often hidden behind precision engineering or microengineering. However, among applied scientists and industrial researchers, it turns out to be crucial for most developments.

Today, for high-end applications such as objective lenses for lithography, astronomical, or space-borne optical systems, optomechanical development tools such as finite element analysis can predict for optical elements the displacement under dynamic load and the distribution of stress or strain or, for example, can analyze adhesive bonding. Although the basics of these tools have been thoroughly investigated since 1987 by V. Genberg et al. and later by K. Doyle et al., its dissemination is still limited to the applications mentioned above. In the future, to compete with the increasing demand of optical quality on the one hand and a higher pressure on costs on the other hand, these techniques become more and more interesting. This becomes especially evident when dealing with complex fabrication processes, such as injection molding, and complex environmental situations, such as combined thermal, mechanical, and humid load for injection-molded optical elements.

In this issue, we hope to cover some of these new challenging aspects of optomechanical aspects.

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