Workshop »Coatings for Optics and Optical Components«

Exploring new frontiers for non-destructive testing in optical coating analysis through the use of Photothermal Common-Path Interferometry

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High-power continuous-wave (CW) laser systems often suffer from strong thermal effects in their optical elements, namely changes in refraction index and thermal expansion. Thermal effects also define the Laser-Induced Damage Threshold (LIDT) performance of optical elements in CW regime and are quantified by the absorptance coefficient. However, thermal lensing may also be observed even below LIDT so that the laser beam becomes unusable due to also strong wavefront distortions. In other words, optical laser elements tend to lose their specified (functional) performance earlier than LIDT is reached. The approximate limit, where the optical element loses functional performance can be regarded as a “Functional” Laser-Induced Damage Threshold (or F-LIDT). Accordingly, there is a need to reduce energy losses in such elements to improve their functional performance and appropriate characterization techniques are needed in the optics development process.

In this talk we will show that a non-destructive Photothermal Common-path Interferometry (PCI) technique is a useful tool for CW laser optics: it allows the characterization of optical absorption losses as low as 0.1 ppm in optical coatings. Due to the spatially and temporally resolved approach multiple PCI test procedures can be realized, namely: “L-scan”, “T-scan”, “2D scan” and “Time-scan”. A full set of data can not only evaluate the absorption values in bulk or surface but also allow predictions of functional optics performance. Furthermore, in combination with laser pulsed irradiation, PCI can be useful to explore both nonlinear absorptance losses via the multiphoton process and absorptance changes over time (fatigue effect). By using the PCI test method, the weakest points in optical coatings can be easily identified in a non-destructive way, therefore, it is an invaluable tool both for optical coating developers and users. To exemplify PCI approach various use case scenarios will be demonstrated and discussed.