Characterization of UV optics

Laser-Laboratorium Göttingen e.V.

At Laser-Laboratorium Göttingen, the performance of optical components for the UV and VUV spectral region is comprehensively characterized, using testing procedures in accordance with ISO standards:

Absorptance (ISO 11551)
Scattering
- *total (ISO 13696)*
- *angular resolved*

Transmittance / Reflectance
Laser-induced damage threshold (ISO 11254)
Degradation (color centers)
Fluorescence / luminescence
Wavefront distortion (lens heating, compaction)

Employed radiation sources:

High power excimer lasers
248nm, 193nm, 157nm
Nd:YAG lasers
1064nm, 355nm, 266nm
laser-induced EUV source
13nm

Absorptance

Absolute absorptance is determined using a high-resolution laser-calorimetric technique with sensitivity in the ppm range. Both linear and non-linear (two-photon) absorption losses can be recorded. Measurements permit a rapid assessment of the long-term performance of DUV/VUV optics at low energy density levels.

direct measurement of absolute absorptance in accordance with ISO 11551

determination of linear and non-linear absorption coefficients

degradation rates without thermal loading of the samples

non-destructive quality assessment

Fluorescence

Temporally-resolved laser-induced fluorescence / luminescence can be monitored during the absorptance measurements with the help of a gateable image-intensified UV spectrometer (cf. Fig. 1).

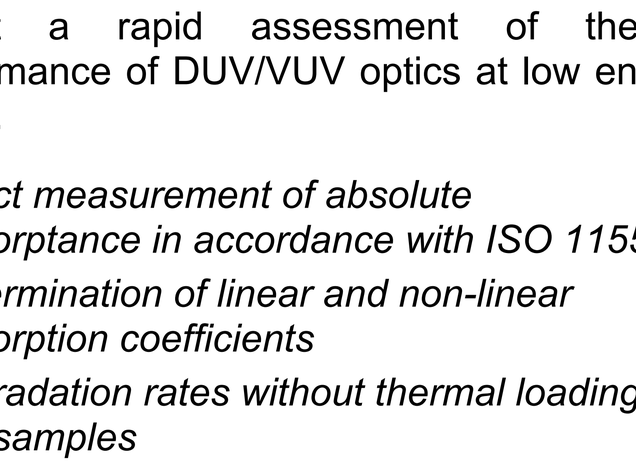


Fig. 1: Luminescence spectra of two different CaF_2 samples irradiated at 157nm

Scattering

Scatter losses in UV optics are determined using a Total Scattering (TS) setup with an excimer laser as pulsed light source and a high-precision Coblentz hemisphere as integrating element, allowing to monitor both forward and backward scattering independently. Moreover, angular resolved scatter data can be obtained.

´at wavelength´ recording of scatter losses in the DUV spectral range
sensitivity: < 1 ppm at 248nm
< 30 ppm at 193nm
scatter maps (cf. Fig. 2, lateral resolution 0.5mm)

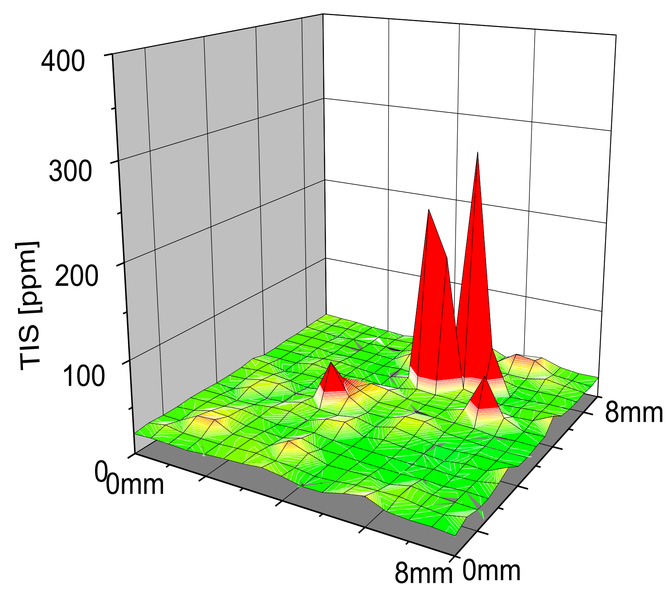
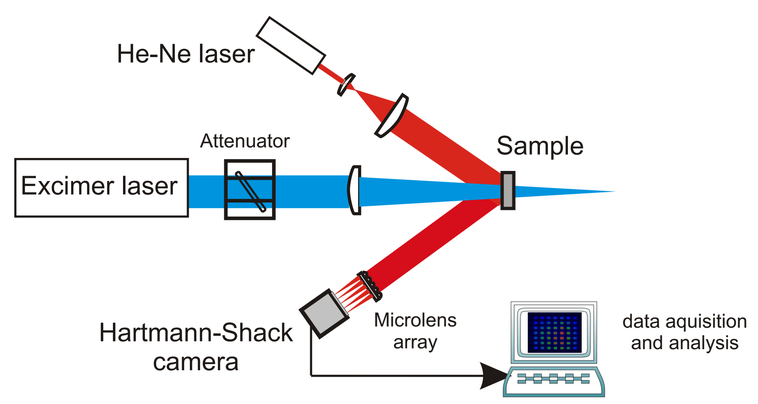


Fig. 2: Scatter map of super-polished CaF_2 at 248nm

Wavefront monitoring during UV irradiation:

Permanent or transient laser-induced deformation of DUV/VUV optical elements (e.g. due to lens-heating, compaction or rarification in fused silica) can be monitored on-line with a resolution in the nm range using a Hartmann-Shack wavefront sensor.



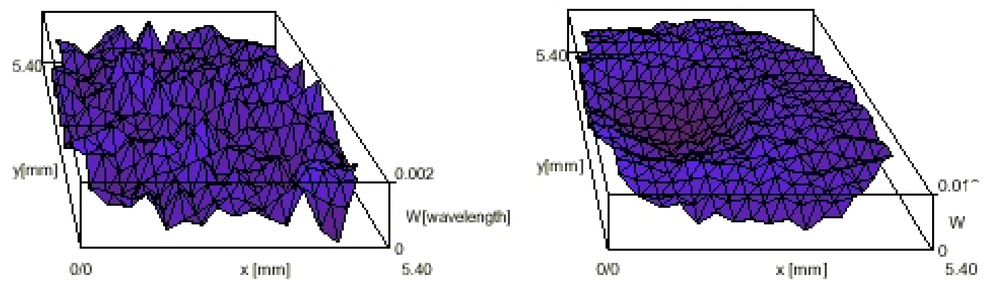


Fig. 3: Compaction of fused silica during ArF laser irradiation monitored with Hartmann-Shack wavefront sensor; above: experimental set-up; left: before irradiation; right: during and after irradiation (densification / ~ 10^{-6}).

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