



Radiation Damage of Optics – WP 7.1.3

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Target - to design, build and test a prototype system capable of in-situ measurement of small changes in optical performance.

Intermediate deliverable – survey of existing possible metrology methods (2 years)

~30 person months allocated to task



Types of radiation damage

- Distortion due to heating
- Change in material properties – refractive index change
- Change in layer structures
- Surface damage - roughness, melting
- Ablation

Single shot, multi-shot.

Beamlines will be designed with single shot energy densities well below thresholds –looking for ‘long term’ changes in optical properties.



Ongoing Measurement of Damage Thresholds.

Work reported at the SPIE 6856 in Prague last spring of work at FLASH and other high power XUV and X-ray sources

Measure **ablation** thresholds of 10's of mJ/cm^2 /pulse at UV wavelengths for common materials

For Si and a-C, see change in refractive index of material at energy densities lower than the ablation thresholds, eg for **Si at 89 nm** the threshold for **refractive index** change is **5 mJ/cm^2** and for **ablation 40 mJ/cm^2** .

Refractive index change observed using Nomarski microscope, no damage seen up by AFM or TOF measurements. See a change in the Raman spectra (amorphisation of Si) - Krzywinski et al, J Appl Phys 101 (2007)



Measurements of damage thresholds – multi-shot

Evidence for lower thresholds for multi-shot damage – eg work on a-C coated Si using Ne-like Ar laser, see damage at 0.5 ablation threshold ($0.5\text{J}/\text{cm}^2$) 10 shots (Juha et al, Proc SPIE 6586)

Damage (roughness) of a-C coated Si after 20 min exposure to 10 nJ pulses, fluence $< 100\text{ }\mu\text{J}/\text{cm}^2$, from HHG source at Saclay (Juha et al, Proc SPIE 5917)



Types of measurements.

- Mass spectroscopy
- LTP – overlap with task 7.3.2
- Wavefront sensing
- Raman Spectroscopy
- Microscopy
- Reflectivity
- Electron spectroscopy
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Require sensitivity to changes in optical properties – spectroscopic, reflectivity or possibly wavefront measurement.

Organisation.

- Survey of existing techniques - STFC
 - FLASH experience
 - who else?
- Test of techniques - measurement of 'slightly' damaged surfaces – are they available? who can contribute which techniques?
- Decision of type of instrument – all of us, needs to be before 2 year delivery date of report, when?
- Design and build – where?
- Test - FLASH