Improving Laser-Damage Performance of UV Coatings: Thin-film, high-reflectance coatings play a key role in transporting UV laser beams at Omega and other high-power UV laser facilities. Improving the laser-damage performance of these coatings is of great importance to achieve the highest-possible output laser energies. Recent research conducted at LLE showed significant progress in understanding laser-induced, UV nanosecond-pulse damage in HfO_2/SiO_2 multilayer coatings used at the Omega Laser Facility. For more than a decade it was known that absorption starts in the HfO_2 component of the coating but the nature of localized nanoscale absorbers remained unknown. In recent LLE experiments with HfO_2 monolayers using artificially introduced 1- to 5-nm–sized Hf metal clusters, it was demonstrated that small metal clusters loosely bound to the matrix cannot explain the spatially homogeneous absorption mapped by high-resolution photothermal heterodyne imaging (PHI).[1] A comparison of the PHI images generated with 0.4-μm resolution for cluster-containing and cluster-free HfO_2 films (Fig. 1) indicates that high-density areas of electronic defects in HfO_2 film material are a major source of UV absorption and damage initiation. These results were complemented by atomic force microscopy (AFM) analysis of damaged coatings (Fig. 2). The AFM study revealed that damage initiation starts at the HfO_2 and SiO_2 films' boundary and involves the transformation of normally transparent SiO_2 into absorbing material. At locations with good thermal contact, the temperature in SiO_2 can rise above the melting point and reach the critical temperature ~2200 K at which point silica transforms into an effectively absorbing material. As a result, energy acquisition from the laser pulse leads to a quick temperature and pressure rise, explosive material removal, and damage. This damage mechanism can be universal for any UV coatings employed at nanosecond-pulse laser systems comprised from HfO_2/SiO_2 pairs. Current work concentrates on finding coating treatments leading to the reduction of absorption in the near-UV spectral range.

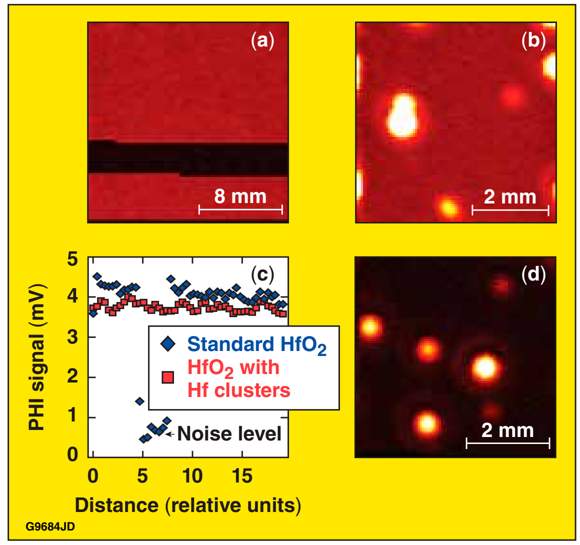

Figure 1. PHI images of HfO_2 samples: (a) regular HfO_2 film without Hf particles and (b) HfO_2 film with Hf particles. (c) PHI linear signal profiles taken from image (a) and from large particle-free areas of image (b). (d) PHI image of the SiO_2 sample with Hf particles. Note the absence of any signal in SiO_2 sample areas between large particles. The dark horizontal band in (a) corresponds to a measurement of the noise level by turning off the pump laser.

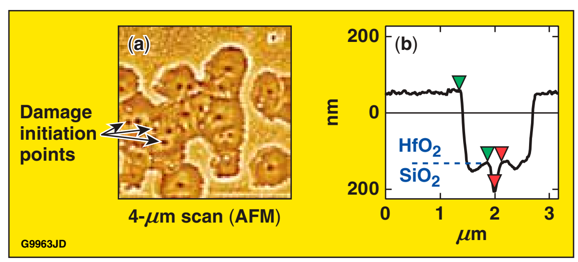

Figure 2. (a) AFM image of damage morphology shows a smooth, glassy structure at the crater bottom, indicative of reaching the silica melting point. Numerous nanoscale protrusions visible inside the merging craters make it possible to estimate the average damage-initiating, localized-absorber separation; (b) cross-sectional AFM profile through an isolated damage crater. The crater-depth measurement points to the removal of the hafnia layer. A central protrusion propagating into the silica layer points to the light absorption in the silica layer at some stage of the damage event.

Omega Facility Operations Summary: During April, the Omega Laser Facility conducted 174 target shots with an average experimental effectiveness of 96% (151 target shots on OMEGA with an experimental effectiveness of 97% and 23 target shots on OMEGA EP with an average experimental effectiveness of 89.1%). In addition, 12 laser maintenance shots were conducted on the OMEGA EP laser. The ICF program accounted for 80 target shots during this period for experiments led by LLE and LLNL scientists. Forty-two target shots were carried out for experiments led by LLNL. Two NLUF campaigns led by the University of California, Berkeley and MIT, respectively, conducted 21 target shots and a total of 31 target shots were taken for LBS experiments carried out by LLNL and LLE scientists.

OLUG Workshop: The Fifth Annual Omega Laser Facility Users' Group (OLUG) Workshop was held at LLE on 24–26 April 2013. The workshop drew nearly 100 university, national laboratory, and industry participants.

1. S. Papernov, J. Appl. Phys. **109**, 113106 (2011).

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