Featured Researcher

Vladimir Liberman

Vladimir Liberman is a researcher in the Submicrometer Technology Group at MIT Lincoln Lab in Massachusetts. His research involves the study of laser-induced modification of optical materials relevant to photolithography. Since the early 1990s his group has been at the forefront of developing future generation optical lithography techniques, starting with 193-nm, moving to 157-nm and now immersion-based photolithography. All of these technologies require assessment of durability of optical materials, such as lenses, optical coatings or immersion fluids for their expected lifetime inside a lithographic tool. With optics worth several million dollars, it is not surprising that end users have high expectations on lifetime.

Lincoln Lab is a Federally Funded Research and Development center of the Massachusetts Institute of Technology. The Laboratory's fundamental mission is to apply science and advanced technology to critical problems of national security. http://www.ll.mit.edu/about/about.html

Vladimir and his group have constructed a number of systems dedicated for long-term irradiation studies that incorporate sensitive in-situ metrology, such as Spectroscopic Ellipsometry (Figure 1). Each chamber is coupled to a high repetition rate excimer laser that irradiates samples for many days, sometimes weeks. Since the in-situ data are automatically acquired several times an hour, vast data sets are generated over the test duration. The goal is to characterize changes that may occur in optical materials with prolonged irradiation, thus anticipating and preventing potential problems that lithography tools may experience years down the road.

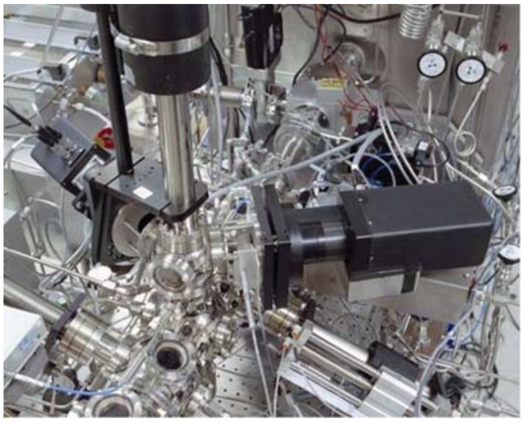

Figure 1. Spectroscopic ellipsometer on MIT-LL Chamber[1]

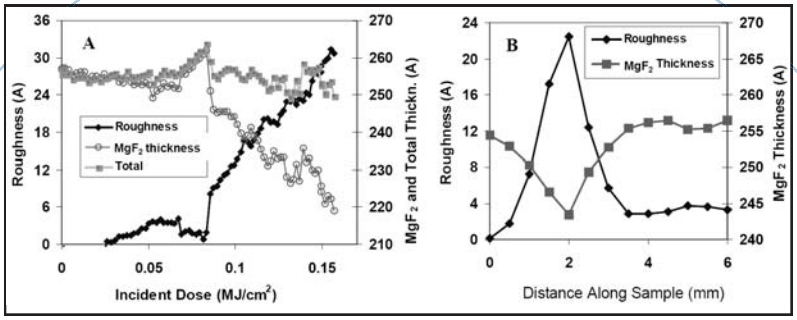

Figure 2. (A) Evolution of surface and (B) spatial profile of MgF_2 film irradiated with 157nm laser.[1]

Spectroscopic Ellipsometry is used in two modes: 1) to monitor damage evolution with time (Figure 2A) and 2) to map post irradiation damage (Figure 2B). The recent shift to immersion-based lithography presents new challenges for implementing in-situ ellipsometry. The probe beam now enters a sealed immersion cell to collect signal from the interior cell surface in contact with the liquid. Due to index matching between the liquid and cell window, the reflected signal levels are quite low, requiring careful alignment. Spectroscopic Ellipsometry was used to study controlled contamination of optics exposed to water with low levels of dissolved photoresist components. The results show a complex spatial pattern of surface contamination, depending on water flow direction and laser intensity distribution. Once again, ellipsometry proved extremely useful in sensitive surface characterization of optics.

Vladimir and his group continue to explore new applications for ellipsometry beyond routine thickness/index characterization. His group has a number of ongoing activities in fabrication and application of nanostructures. They hope that ellipsometry, with its extreme surface sensitivity, will play a role in these studies.

When not in the lab, Vladimir can often be found playing violin with his friends: either classical music with a local symphony orchestra, or klezmer music with his band on the streets of Cambridge or Brookline.

---

[1] V. Liberman et al., "Photo-induced changes in 157-nm optical coatings," Proc. SPIE, v 5377, n 1, 2004, p 131-40.