Progress in multilayer reflective coatings for extreme-ultraviolet lithography

J.A. Folta, S. Bajt, R.F. Grabner, M.A. Schmidt, R. Soufli, E. Spiller, C.C. Walton, M. Wedowski, and C. Montcalm

Information Science and Technology
Lawrence Livermore National Laboratory
P.O. Box 808, L-395, Livermore, California 94551.

Abstract

Multilayer mirror coatings that reflect extreme ultraviolet (EUV) radiation are a key enabling technology for EUV lithography but must meet stringent requirements in terms of reflectance, stress and stability. Multilayers with reflectances of 69.5% at 13.4 nm and 70.2% at 11.4 nm have been achieved for Mo/Si and Mo/Be, respectively. These multilayers were exposed to high doses of synchrotron-based EUV radiation—the reflectance and film stress appear to be stable relative to the requirements for application to EUV lithography. Deposition technology has been dramatically improved to meet the specifications for thickness control and repeatability over large curved optical substrates. Coating uniformity was improved to ±0.05% peak-to-valley (P-V) on 140-mm flats and ±0.1% P-V across 160 mm curved substrates. The run-to-run reproducibility of the reflectance peak wavelength was improved to 0.13% for wavelength-matched sets of optics. These improvements in EUV multilayer mirror technology enable us to meet the requirements for next-generation EUV lithographic systems. The primary remaining issue is verifying the long term stability of the multilayers within the environment of a production EUV lithographic system.

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Correspondence: E-mail: folta1@llnl.gov, Voice: 925-423-5881, Fax: 925-423-1488