EUV multilayers with high thermal stability

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Many applications of multilayers in EUV spectral region require not only high normal incidence reflectivity of nearly 70% but also high thermal stability. A potential problem of Mo/Si multilayers is the formation of amorphous interlayer diffusion zones during the deposition process. It is known that the decrease of multilayer reflectivity after annealing above 250 °C is connected with broadening of interlayers and crystallization of silicides. All structural studies of Mo/Si multilayer crown over a wide range of different deposition conditions show that pure layer materials are seperated by interlayer diffusion zones. Characterization of the interface formation process and new approaches for stabilisation of interfacial reactions are required for high reflectivity and high thermal stability of multilayers.

We investigated the thermal stability of traditional Mo/Si multilayers in comparison to the new material combination Mo_2C/Si in the temperature range from 300 °C to 800 °C. Additionally we deposited and studied Mo/Si multilayers having Mo_2C and $MoSi_2$ diffusion barriers with 0.6 nm single layer thickness. All multilayers were designed for normal incidence reflectivity at 13.4 nm wavelength. Multilayers were deposited by dc magnetron sputtering using a negative substrate bias voltage that produces bombardment of the growing films by sputtering gas ions. X-ray scattering, atomic force microscopy, transmission electron microscopy, mechanical stress measurement and chemical analysis were used for characterization of multilayer structures. The results are correlated to the measured normal incidence reflectivity using synchrotron radiation.