Interface structure and interdiffusion in Mo/Si multilayers

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The successful application of Mo/Si multilayer coatings as reflective optics in EUV lithography systems depends strongly on their absolute reflectance as well as their stability under EUV irradiation. These macroscopic properties are intrinsically coupled to the microscopic layer properties, and more importantly, the behavior at the *interfaces* between layers.

The formation and development of Mo-Si interfaces in Mo/Si multilayers upon thermal annealing, including a transition to *h*-$MoSi_2$, has been investigated using high resolution transmission electron microscopy, X-ray reflectivity and X-ray diffraction measurements. We investigated the nano-crystallinity of Mo/Si multilayers as a function of Mo:Si ratio in the period for as deposited samples and after thermal annealing up to 800 C under UHV conditions. The research was performed on EUV multilayers with period thickness of approximately 7 nm. The as-deposited multilayer nanostructure was found to depend on the Mo to Si layer thickness ratio. Using the crystallographic properties of the multilayer during annealing, we describe the continuous development of the multilayer structure and growth of the silicide interfaces. Our study has led to an explanatory model which is based on the total free energy minimization of the multilayer system.

Finally, we report for the first time an asymmetry in B_4C barrier layer formation, where for B_4C-on-Mo the correct stoichiometry is formed, while for B_4C-on-Si the XPS depth profile suggests C-diffusion out from the B_4C interfaces into the multilayer. We explain the formation of B_4C with different stoichiometries at Mo-Si interfaces by the different structure of the layer onto which B_4C is grown.