Solid state diffusion in multilayered structures on a picometer lengthscale

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Multilayered Extreme UV mirrors present unprecedented fundamental questions to solid state diffusion, requiring understanding of diffusion phenomena on length scales of only few picometers. Using x-ray diffraction applied in situ during thermal annealing, we have investigated diffusion processes in Mo/Si multilayers at the very initial stage of compound interface formation. Grazing incidence x-ray reflectometry resolves picometer structural changes in the multilayer structure as a function of time and temperature and reveals diffusion limited compound interface growth. The temperature dependence of the measured diffusion constants exhibits Arrhenius-like diffusion behaviour with an increasing activation energy during interface growth that may explain the range of activation energies reported for this system in literature. The method and results presented here are relevant for understanding and controlling diffusion processes on a picometer length scale, with potential spin-off to semiconductor and other thin film applications.