Smoothing properties of single- and multilayer coatings, a method to smoothen substrates.

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The throughput of an EUVL optical system is to a large extent determined by the near normal incidence reflectance of the multilayer coatings. Reflectivities above 70% have been reported on multilayers deposited on super polsihed fused silica and super polished silicon substrates that have a high spatial frequency roughness of 0.1 nm or below.

On real substrates to be used in exposure tools, where the mid spatial frequency roughness and the figure have to be extremely low as well, the high spatial frequency roughness can be slightly higher than on the super polished test samples, resulting in a lower reflectance of the multilayer.

In this work we present the smoothing properties of our ion beam smoothened multilayers and, based on the same technology, the extreme smoothing properties in the high and near mid spatial frequency range of a single-material smoothing layer.

The surface roughness evolution as a function of layer thickness, during deposition as well as during ion beam erosion, can conveniently be modeled in the reciprocal space of the surface topology given by the Power Spectral Density. Based on simple kinetic expressions the spatial frequency dependence of processes like smoothening by viscous flow and surface difussion can be derived*. According to the model thus obtained, assuming a fixed set of smoothening and roughening parameters, independent on changes of the surface topology during ion bombardment, smoothening should occur during ion induced erosion of several hundreds of nanometers, depending on the initial surface roughness. Experimental results however, show that when a very thick single material layer is eroded by ion polishing, the smoothening mainly occurs when during removal of the first one hundred nanometer. A more appropriate model to describe this phenomenon will be presented.

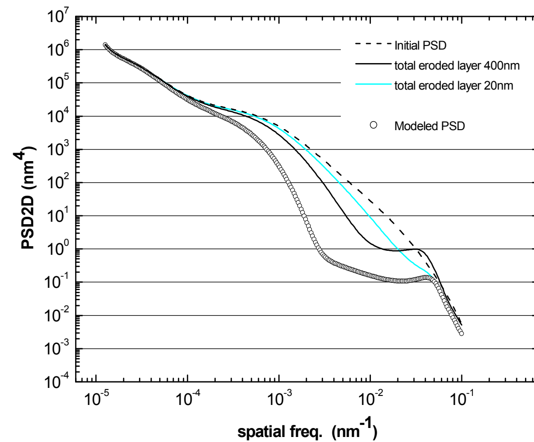

Fig.1) Modeling the roughness PSD of a Si layer after erosion of 400 nm by ion bombardment, based on parameters found corresponding to 20nm erosion, clearly overestimates smoothing.

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