Interface morphology of Mo/Si MLs prepared by various deposition techniques

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The Mo/Si multilayers (MLs) were prepared by UHV e-beam deposition in the dry vacuum of 10^{-8} Pa onto Si 100 substrates covered by a native oxide. Three different deposition procedures were used: standard deposition technique at room temperature, deposition at the increased substrate temperatures 160 - 200°C, and in situ ion polishing of Si layers by Ar^{+} 800 eV at the angle of incidence 35° with respect to the substrate surface (room temperature deposition). The interface morphology under different fabrication conditions was studied by hard and soft X-ray reflectivity measurements, interface diffuse scattering of X-rays at the grazing incidence and CS TEM inspection. As expected, the soft X-ray reflectivity was increased by choosing the proper deposition temperature (175° C) or by ion polishing.

The experimental data were evaluated using Fresnel optical algorithm and a semikinematical modification of the distorted wave Born approximation. The results are summarized in the Table.

Table 1 Parameters of the Mo/Si MLs: (N) number of periods, (d_X) layer thickness, (D) ML period, (σ) rms interface roughness, (ξ) lateral correlation length, (L)vertical correlation length. RT - room temperature deposition, H - deposition on the heated substrate, IP - ion polishing.

sample	**N**	d_{Mo}	$d_{Mo\text{-}Si}$	d_{Si}	$d_{Si\text{-}Mo}$	**D**	σ	ξ	**L**
		[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]
RT	14	17	7	38	11	73	6.5	300	300-600
H	30	15	9	35	15	68.5	3.5	200	500-1000
IP	30	15	7	38	10	70	3.5	200	500-1000

In the simulations the Mo_5Si_3 interlayer at Mo on Si and Si on Mo interfaces was assumed. In the Table the results of simulations with identical roughness of both interfaces are displayed. However, it was observed the different interface roughness of Mo on Si and Si on Mo interfaces can explain some fine differences in the diffuse scattering spectra (omega scans) The largest thickness of the Mo-Si interlayer was found for sample deposited on the heated substrate. The decrease of the interface roughness in H and IP samples corresponds to their increased soft X-ray reflectivities (in comparison with the RT sample). The decrease of lateral correlation length and increase of vertical conformity of the interfaces in H and IP samples is discussed within the framework of growth model including the surface diffusion and ion momentum transfer.

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