Evolution of surface morphology during growth and ion erosion of thin films

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A model is presented to describe the evolution of thin film surface morphology during growth and ion erosion. In our model, we closely follow the derivation and terminology of the growth model of Stearns [1, 2] and Spiller *et al.* [3], Our inclusion of smoothing and roughening mechanisms differs from theirs, but is equivalent to the treatment by Mayer *et al.* [4]. Thus, roughness is introduced by shot noise in the deposition rate, and by variations in the ion erosion rate with surface curvature. Smoothing mechanisms in our model are surface diffusion and viscous flow. The latter is only taken into account during ion erosion.

The behaviour is studied of characteristic in-plane length scales and overall amplitude of the roughness, given the certain competing roughening and smoothing mechanisms. Particular attention is paid to the deposition method of growth followed by ion erosion of an excess layer thickness ("ion polishing"). The model is extended to the case of multilayers, to include roughness correlations between different interfaces.

Specular and diffuse X-ray scattering measurements on four ion polished Mo/Si multilayers are presented. In these samples, the excess layer thickness was varied. As measured before [5], the diffusely scattered X-ray intensity falls off exponentially in all $q_\perp$ ("transverse"-) scans from these samples. Quantitative agreement between the model and the experimental data can be achieved if we assume viscous flow (rather than surface diffusion) to be the dominant smoothing mechanism during ion erosion of the Si layers.

References

[1] D. G. Stearns, J. Appl. Phys. **71**, 4286 (1992).

[2] D. G. Stearns, Appl. Phys. Lett. **62**, 1745 (1993).

[3] E. Spiller, D. G. Stearns, and M. Krumrey, J. Appl. Phys. **74**, 107 (1993).

[4] T. M. Mayer, E. Chason, and A. J. Howard, J. Appl. Phys. **76**, 1633 (1994).

[5] R. Schlatmann, J. D. Shindler, and J. Verhoeven, Phys. Rev. B **51**, 5345 (1995).