1. Title:	Advanced process for Mo-Si multilayer formation using an assisted ion beam for EUVL mask blanks
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3. Abstract body:

Defect-free masks are critical to the use of extreme-ultraviolet lithography (EUVL) for the high-volume manufacture of LSIs. To make low-defect-density mask blanks with Mo-Si multilayers, we have developed a sputter deposition system that can employ either ion-beam sputtering (IBS) or magnetron sputtering (MS). [1] Another essential characteristic of a Mo-Si multilayer mirror for mask blanks is a high reflectivity in the wavelength range of 12-15 nm. We analyzed Mo-Si multilayers formed by IBS and MS using transmission electron microscopy (TEM) and Rutherford back-scattering (RBS) measurements. The results showed that the interface layer (0.5-1.5 nm thick) arising from the intermixing of Mo and Si atoms during coating degrades mirror reflectivity. A comparison of Mo-Si multilayers formed by IBS and MS showed that the interface layer was 30-50% thinner for MS than for IBS. [2] To reduce the interface layer thickness, we devised a new process that involves treating the surface of the Si layers with an assisted ion beam (AIB) of Ar or oxygen in combination with sputter deposition. Atomic force microscopy (AFM) measurements of the surface of two Mo-Si bilayers showed a 20% improvement in root-mean-square (RMS) roughness for Ar ion-beam treatment and no degradation for oxygen ion-beam treatment. X-ray diffraction measurements indicate substantial differences in the Mo-Si interface after the two types of AIB treatment.

In the symposium, our advanced technology for the formation of multilayers will be described, including a new coating process that involves surface treatment with an AIB. And the results of TEM and RBS analyses that show how effective our new process is will be presented.

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References

1. H. Yamanashi et al., 2nd International EUVL Symposium, Antwerp, Belgium, 30 Sep.-2 Oct. 2003.

2. K. Hiruma et al., SPIE Conference on Emerging Lithographic Technology X, San Jose, Feb.20-24, 2006. No. 6151-68.