Investigation of Soft X-ray Multilayer Mirror Fabrication by an *In-Situ* Ellipsometric Deposition Monitor

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Soft X-ray multilayer mirrors are key components for high resolution imaging in soft X-ray microscope and other applications. For high reflectance at wavelengths of a few to several tens nm, the multilayer has to be fabricated at optimized condition for the smoothest interface at every boundary.

To investigate the layer structure during ion beam sputtering fabrication of Mo/Si multilayers, we have applied our *in-situ* automatic null ellipsometer [1] with rapid layer-by-layer analysis [2]. Figure 1 shows two sets of *in-situ* data observed at Ar ion acceleration voltages of 1400 V and 900 V. The ellipsometric data of the complex relative amplitude attenuation were recorded at every 150 msec and plotted on a complex plane as growth curves. A growth curve of each period is composed of a Mo segment and a Si segment up to the final layer. At the latter stage of fabrication, the growth curve should form a closed-loop as depicted in Fig. 1. This is because the total thickness of the multilayer exceeds the penetration depth of the incident He-Ne laser light.

Direction and length of each segment on the complex plane represent the optical constants and layer thickness, respectively. Therefore, the growth curves visualize differences of layer properties.

Judging after the growth curve properties [3], Mo forms an island structure on Si at 1400 V growth in the early stage just after a target switching. In contrast, a silicide layer is likely to form on Si with no Mo island growth at 900 V. These information could be essential to study for ideal homogeneous and isotopic layer growth.

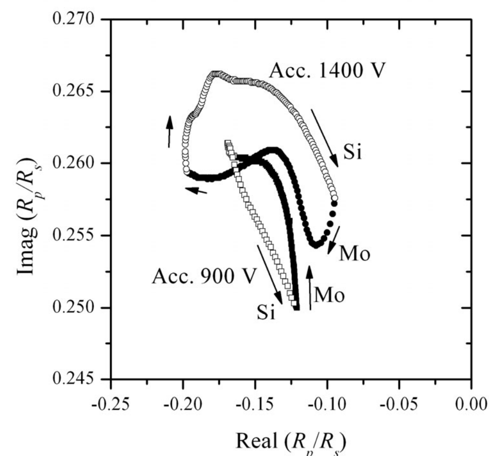

Fig. 1 Ellipsometric growth curves of Mo/Si multilayer at the 30th period measured at acceleration voltages of: 1400 V (circles) and 900 V (squares). Sputtering durations of Mo and Si were for 240 sec and 280 sec, respectively.

References

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[3] M. Yamamoto, T. Namioka, Appl. Opt. **31** (1992) 1612