

	Experiment title X-ray diffraction from Mo and MoSi crystallites in Mo/Si multilayer coatings for Extreme UV Lithography	Experiment number SI-606
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Shifts	Local contact(s) Dr. E. Ziegler	<i>Received at ESRF</i>
Names and affiliations of applicants (* indicates experimentalists) Drs. E. Louis*, Mr. I. Wever*, Dr. A.E. Yakshin, and Dr. F. Bijkerk* <i>FOM-Institute for Plasma Physics Rijnhuizen, Nieuwegein, The Netherlands</i> Dr. E. Ziegler* <i>ESRF, Optics Group, Grenoble</i>		

Report

This is a preliminary report of experiments carried out at ESRF from 7 to 12 February at BM5. Due to the availability of manpower, a full analysis of samples is scheduled for the period starting April 1. This report covers a description of the experimental activities at ESRF and conclusions from first analysis of the measurements at FOM.

Experiments

In order to avoid any effects from polarization, a vertical geometry was selected for the goniometer (use of s-polarized light). Considerable effort was put in the setting up of the goniometer and its alignment. Solutions were found to initially noisy detector signals and wavelength dependent backgrounds by improving the shielding from scattered radiation. Also the higher order contributions from the monochromator could be eliminated (by using a Pt mirror at a grazing angle of 0.37°).

Though first measurements were done at 8 keV, similar as the pilot experiments at FOM using a lab source, a move to 16 keV incident radiation showed substantially improved diffraction spectra. Reasons for this are the enhanced penetration depth in the multilayer sample, and reduced absorption in the optical path in combination with the higher efficiency of BM5 for 16 keV photons. Encouraging was also the rapid collection of data: typical scans took less than an hour, while high resolution scans could be taken in a few hours, to be compared with low resolution spectra of low signal/noise ratio recorded with the FOM lab source which took more than 30 hours. In the beam time available, and after the adjustments of the specific goniometer set-up, a limited number of samples could be measured. Below are our preliminary conclusions.

Conclusions

- Clear diffraction spectra have been recorded, indicating crystallization in the Mo layer and in the Mo-silicide interfaces zones. Identification of the different lines is in progress.
- Clear indications have been found of a preferred orientation of the nanocrystals. This could be concluded from a comparison of diffraction scans done at different angles of the incident radiation, and the diffracted intensity from the different crystal planes (see Fig. 1).
- A difference of the nominal position of the diffraction peaks and the observed position tentatively is ascribed to the presence of stress in the nanocrystallites.
- A relation is found between the multilayer fabrication method and the crystallization effects observed. Based on this first observation, a new series of samples is being produced, and will be analysed on reflective properties.

It is noted that a full study of most phenomena listed above does require more analysis, but also an additional period of beam time. A proposal for this has been submitted to the March 1, 2001 call.

Fig. 1. Comparison of a wide angle diffraction scan at two different angles of incidence. Though a full analysis is still under study, the different spectra clearly suggest a preferred orientation of the Mo crystals. This is tentatively ascribed to the crystal nucleation process during the multilayer growth.

