Development of EUV reflective Micro Mirror Arrays for Maskless lithography applications

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EUV is the prime candidate technology for economical extension of the lithography roadmap beyond 32nm half-pitch. Mask- based EUV tools, which are currently being made available, are most suited for high-volume production facilities such as memory and microprocessor manufacturing. However, many potential EUV customers do not have large series products but are specialized in e.g. ASICs or logic semiconductors for e.g. mobile phones and entertainment devices. Because of the more limited volumes, the EUV mask becomes a dominant cost factor in the production process. For those customers a maskless EUV solution would be very attractive.

The main challenge for a maskless EUV scanner is in the generation of the patterns. Because the maskless system does not have a reticle which carries all the pattern information these patterns need to be generated inside the tool. The contrast device for such a tool will be a Spatial Light Modulator (SLM). SLMs with an aluminum top reflective layer can be used for Optical Maskless Lithography (OML) at 248 and 193 nm wavelengths. Extension of OML technology to EUV (13.5 nm) requires the application of an EUV reflective coating, e.g. a Mo/Si multilayer. The flatness requirements of the SLM mirrors require an extremely low stress component in the EUV reflective multilayer stack. Also, the SLM production process needs to be adapted not to deteriorate the optical performance of the EUV reflective multi layer coating. Note that the multilayer coating is relatively thick (280 nm) with respect to the micro mirror thickness (~400 nm). The stress and stress gradients in the multilayer will thus cause the micro-mirror to warp.

To investigate the coating technology and imaging performance of EUV compatible SLMs we performed a number of coating experiments using different recipes to optimally tune the stress and thereby the flatness of the SLM mirrors while maintaining reflectivity. To test these devices we built an at wavelength test stand in which we can image a SLM onto a CCD camera using EUV radiation. Figure 1 shows an image of a multilayer coated SLM sample together with the measured reflectivity. Figure 2 shows a drawing of the test stand. A Xe discharge source is used to illuminate the SLM after which a single toroidal mirror images the SLM onto a CCD camera. The other mirrors are used to fold the beam path. Also an aperture can be inserted in the back focal plane of the toroidal mirror. A large aperture can be inserted to use the optics in microscopy mode. With the insertion of a smaller aperture the imaging conditions of a litho tool can be simulated.

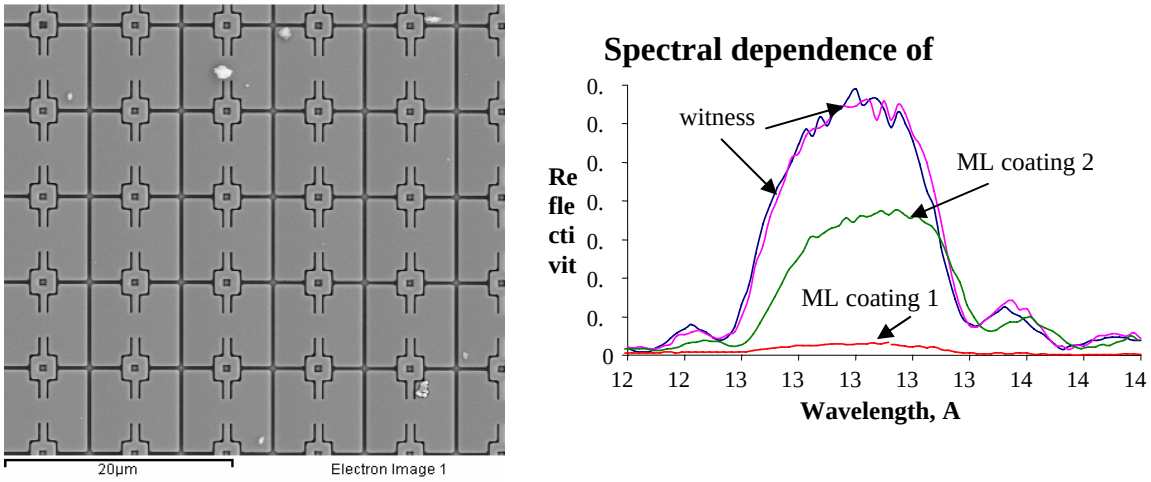

Fig 1: SEM image of a multilayer coated SLM and the EUV reflectivity of two different coatings.

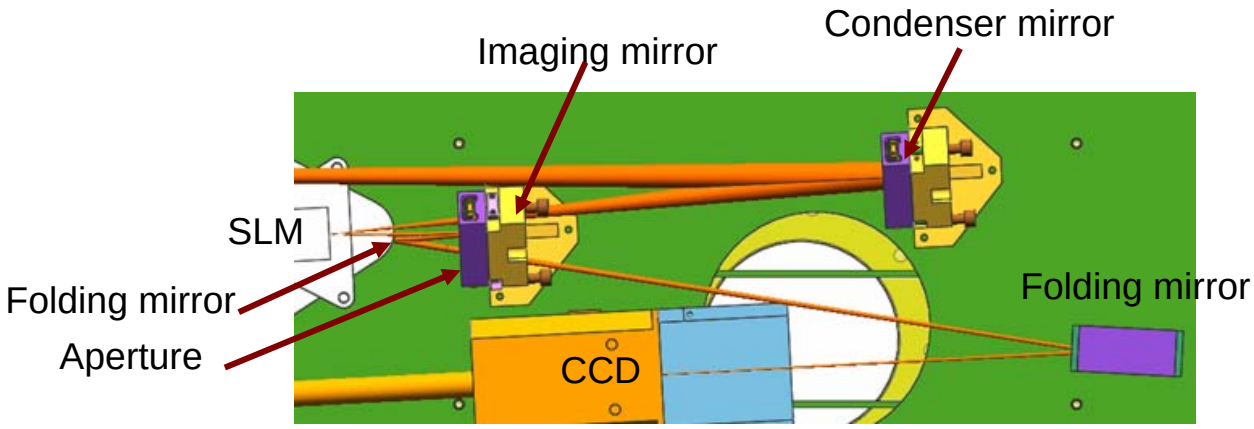

Figure 2: Schematic view of the at wavelength test stand