**EUV optics with integrated IR suppression gratings**

Torsten Feigl[1], Marco Perske[1], Hagen Pauer[1], Tobias Fiedler[1], Uwe Zeitner[2], Robert Leitel[2], Hans-Christoph Eckstein[2], Philipp Schleicher[2], Sven Schröder[2], Marcus Trost[2], Stefan Risse[2], Christian Laubis[3], Frank Scholze[3]

*1 optiX fab GmbH, Hans-Knöll-Str. 6, 07745 Jena, Germany*
*2 Fraunhofer IOF, Albert-Einstein-Str. 7, 07745 Jena, Germany*
*3 PTB Berlin, Abbestr. 2-12, 10587 Berlin, Germany*

Today's EUV source concepts for EUV Lithography focus on laser-induced plasma generation using $CO_2$ lasers in combination with Sn droplets. Different approaches of $CO_2$ laser suppression have been discussed and realized in the past such as binary phase gratings and $CO_2$ AR coatings. While $CO_2$ AR coatings suffer from a significant EUV reflectance loss at 13.5 nm wavelength, binary phase gratings for 10.6 µm show great advantages in terms of EUV reflectance, IR suppression factors and mechanical stability. Binary grating structures for 10.6 µm are implemented in today's LPP collector mirrors. They significantly suppress the $CO_2$ laser wavelength of 10.6 µm and contribute to clean EUV photons in the intermediate focus.

Since pre-pulse technology significantly enhances the conversion efficiency of EUV generation, source manufacturers use this technique to condition the Sn droplets. Different types of pre-pulse lasers are in operation today: $CO_2$ pre-pulse lasers operating at 10.6 µm and YAG pre-pulse lasers operating at 1064 nm. As a consequence the combination of a 10.6 µm main pulse $CO_2$ laser and a 1064 nm pre-pulse YAG laser would require a spectral purity filter that suppresses both wavelengths at the same time.

The talk discusses a new approach of a dual-wavelength spectral purity filter to suppress 10.6 µm and 1064 nm IR radiation at the same time. The dual-wavelength spectral purity filter combines two binary phase gratings that are optimized for 10.6 µm and 1064 nm, respectively. The dual phase grating structure has been realized on test samples and on elliptical sub-aperture EUV collector mirrors having a diameter of 150 mm. IR suppression factors up to 1000 at 10.6 µm and 1064 nm and EUV reflectance levels of more than 60 % at 13.5 nm have been measured on the sub-aperture EUV collectors. The optical performance at 13.5 nm and the IR suppressions at 10.6 µm and 1064 µm as well as the manufacturing process of the grating structures will be discussed in the paper. The dual-wavelength spectral purity filter can be used in future EUV collector mirror generations to suppress the pre- and main-pulse IR radiation.