EUV mask stack optimization for enhanced imaging performance

Eelco van Setten[a], Mircea Dusa[b], Kees Feenstra[a], Christian Wagner[a]
Markus Waiblinger[c], Thorsten Hofmann[c], Thomas Scherübl[c]
[a]ASML Netherlands B.V., De Run 6501, 5504 DR Veldhoven, The Netherlands
[b]ASML Belgium bvba., Kapeldreef 75, 3001 Leuven, Belgium
[c]Carl Zeiss SMS GmbH, 07740 Jena, Germany

EUVL requires the use of reflective optics including a reflective mask. The reticle blank contains a reflecting multilayer, tuned for 13.5nm, and an absorber which defines the dark areas. An EUV mask is a complex optical element with many more parameters than the CD uniformity of the patterned features that impact the final wafer CDU. Peak reflectivity, centroid wavelength and absorber stack height variations need to be tightly controled for optimum performance. Furthermore the oblique incidence of light in combination with the small wavelength compared to the mask topography, causes a number of effects which are unique to EUV, such as an H-V CD offset and an orientation dependent pattern placement error. These so-called shadowing effects can be corrected by means of OPC, but also need to be considered in the mask stack design.

In this paper we will show that it is possible to reduce the sensitivity to mask making variations such as capping layer thickness, centroid wavelength and absorber stack height variations significantly, leading to a better wafer CD uniformity. The impact of absorber stack height variations on CD and placement will be determined experimentally by means of local absorber stack height differences using the MeRiT-32 reticle repair technology from Carl Zeiss in combination with exposures on ASML's alpha demo tool. Features down to 27nm half pitch will be evaluated for multiple masks, comparing process windows and CD uniformity. The outcome may serve as a guidance for EUV mask manufacturing.

Key words: EUV lithography, imaging, masks