Towards sub-10 nm node by EUV lithography

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Extreme ultraviolet (EUV) lithography is currently considered as the most promising alternative to DUV immersion lithography for increasing further the resolution in high-volume semiconductor manufacturing at technology nodes below 22 nm half-pitch. [1] In addition to the development of EUV scanners with projection optics, EUV interference lithography (EUV-IL) has recently been attracting growing interest as a powerful tool in academic as well as in industrial research. EUV-IL combines the simplicity of IL and the short wavelength advantage of EUV light, therefore being an effective method of making high-resolution nanostructures over large areas. EUV-IL tool at PSI is the world-leading tool with a resolution of down to 7 nm half-pitch.

Some challenges need to be overcome before EUV-IL can enter industrial production phase. One of the main ones is the development of EUV resists fulfilling the strict sensitivity, resolution and line-edge roughness (LER) requirements. [2-3] Chemically amplified resists (CARs) where improved sensitivity is achieved via chemical amplification, have been the major paradigm in the global effort of EUV resist development. Nevertheless, we observe a slow-down in the progress of CARs for EUV. Therefore, new resist paradigms have been explored in recent years with increasing attention, such as inorganic resists incorporating metals or nanoparticles with high EUV absorption. Here, we report on the results of our resist screening efforts with the main focus on investigating a wide range of CARs in their developmental phase from our collaborators from around the world. We present a detailed analysis of the performance of these materials and discuss the observed trends with a particular focus on identifying the most promising materials when moving towards 10 nm HP resolution. As the patterned feature sizes approach 10 nm HP, pattern collapse due to capillary attraction forces becomes a significant problem. We present our results on novel rinsing and pattern freezing methods that significantly mitigate the issue.

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[1] G. Tallents, E. Wagenaars, and G. Pert, Nature Photonics **4**, 809 (2010).
[2] Y. Ekinci, M. Vockenhuber, M. Hojeij, L. Wang, and N. Mojarad, Proc SPIE **8679**, 867910 (2013).
[3] Y. Ekinci, M. Vockenhuber, N. Mojarad, D. Fan, Proc SPIE **9048**, 904804 (2014).