High-Resolution E-Beam Repair for Nanoimprint Templates

Marcus Pritschow [a], Harald Dobberstein [b], Klaus Edinger [b], Mathias Irmscher [a], Douglas J. Resnick [c], Kosta Selinidis [c], Ecron Thompson [c], Markus Waiblinger [b]
[a] IMS Chips, Allmandring 30a, D-70569 Stuttgart, Germany
[b] Carl Zeiss SMS GmbH, Carl Zeiss Promenade 10, D-07740 Jena, Germany
[c] Molecular Imprints, Inc. 1807-C W. Braker Lane, Austin, TX 78758, USA

UV nanoimprint lithography (UV-NIL) is a high-throughput and cost-effective patterning technique for complex nano-scale features and is considered a candidate for the 22nm node and beyond. Using state-of-the-art variable shaped beam (VSB) pattern generators and commercially available resists templates with full-field flash gate layers have already been demonstrated. The results approached the specifications for the 32nm node requests in terms of resolution, line edge roughness, placement and uniformity [1]. Recent improvements of template patterning using a VSB tool even showed the capability towards full-field templates for device manufacturing below 32nm half-pitch [2].

In UV-NIL high-resolution template patterns are replicated into a monomer layer deposited on a substrate. Pattern defects resulting from e-beam patterning and subsequent pattern transfer processes significantly contribute to imprint defectivity [3]. Thus inspection and repair are two essential components of the template fabrication chain. E-beam repair with its advantages of precise beam placement using fine resolution images and damage free repair by e-beam induced chemical reactions is a promising repair technology for high-resolution imprint templates. Recently, we demonstrated gas assisted e-beam repair of UV-NIL templates by applying recipes specifically tailored for NIL repair requirements [4].

In this work an e-beam repair test stand with improved beam and stage stability has been used. We investigated the repeatability of 3D pattern reconstruction with main focus on the height control of the deposition and etch processes. Additionally, we examined the resolution capability of the improved hardware on selected programmed defects in order to address possible requirements for imprint repair tools of future generation nodes. Repairs of programmed defects with different types and sizes were made to a fused silica mask of the 65mm form factor and repair results were analyzed by SEM inspection. Imprints were performed to examine the stability of the repaired defects.

[1] J. Yeo et al. “Full-field imprinting of sub-40nm patterns”, Proc. SPIE 6921, 692107 (2008)
[2] S. Sasaki et al. “UV-NIL template making and imprint evaluation”, Proc. SPIE 7271, 72711M (2009)
[3] I. McMackin et al. “High resolution defect inspection of step and flash imprint lithography for 32 nm half-pitch patterning”, Proc. SPIE 6921, 69211L (2008)
[4] M. Pritschow et al. “Evaluation of e-beam repair for nanoimprint templates”, Proc. SPIE 7122, 71222L (2008)

Keywords: Nanoimprint Lithography, Template, Repair