Hybrid Tri-Layer Stamps for Step and Repeat Imprint Lithography

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Nano-imprint lithography (NIL) is a simple pattern transfer that is not limited by diffraction, scattering effects or secondary electrons and does not require any sophisticated radiation optics. These simplified requirements lead to its low cost; however, as feature sizes of the UV-NIL templates are the same as the imprinted structures, there are enormous challenges in writing high resolution templates, particularly over large areas. High resolution template formation undergo back-end processes, including high resolution electron beam lithography; but at the smallest feature sizes, the throughput is very slow and field (die) sizes are limited. In [1]step-and-repeat imprint lithography the die is repeatedly imprinted onto the substrate. This technique is based upon superior flatness tolerances to obtain defect free and uniform imprints with highest resolution (sub 40 nm). Certainly with increasing die area surface roughness, flatness of the stamp and substrate are becoming a major hurdle limiting step-and-repeat imprint lithography, with hard quartz templates, to a maximum die size of about 1" by 1". [23]Soft stamps, a well established alternative for large area full field imprinting, rely on cheap disposable materials with high transparency and flexibility for increased imprint area and low surface energy for self-releasing properties. However, there are properties inherent to polymers, such as their low Young's modulus, that can strongly limit soft stamp imprinting capabilities. Requirements such as sub 40 nm resolution, high overlay alignment accuracy and aspect ratios exceeding 1:1 make the use of a low Young's modulus material not viable. To combine rigidity and flexibility, [4]hybrid, tri-layer stamps (Figure 1) with a hard structured top layer (white) and a soft compliant layer (red) mounted on a carrier template (blue) are proposed in this work. Hybrid tri-layer stamps for step-and-repeat imprint lithography address major step-and-repeat limitations of typical quartz stamps, like maximum die area, uniformity and still maintain advantages in resolution (Figure 2) and overlay alignment accuracy. The work will furthermore address critical stamp parameters like bonding durability between; as well as minimum stamp release force for multi-use without the need of anti sticking treatment for improved cost of ownership.

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[1] G. Kreindl, T. Glinsner, R. Miller, D. Treiblmayr, R. Födisch, *High Accuracy Lithography step-and-repeat master stamp fabrication for wafer level camera application*, J. Vac. Sci. Technol. B 28, C6M57 (2010)

[2] B Vratzov; A. Fuchs, M. Lemme, B. Henschl, H. Kurz, *Large scale UV-based nanoimprint lithography*, J. Vac. Sci. Technol. B 21(6), Nov/Dec 2003

[3] Bender, et.al., *High resolution lithography with PDMS*, J. Vac. Sci. Technol. B: Microelectronics and Nanometer Structures 22(6), pp. 3229-3232 (2004)

[4] U. Plachetka, et al., Comparison of multilayer stamp concepts in UV-NIL, Microelectronic Engineering 83 (2006) 994-997

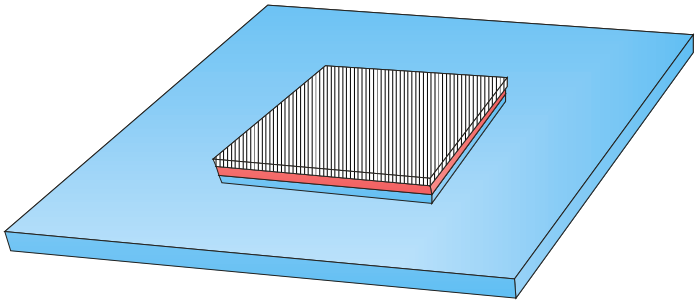

Figure 1: Schematic overview of a hybrid tri-layer step-and-repeat template

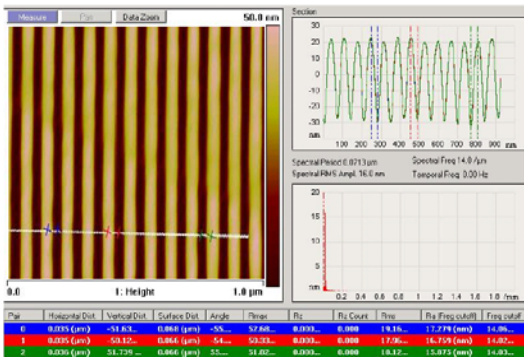

Figure 2: Atomic force microscope (AFM) image of a 35 nm half pitch hybrid tri-layer step-and-repeat stamp