Large area fast patterning in high resolution by a combined near-field exposure and reversal imprint lithography

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The next generation lithography (NGL) requires the lithography method to be high resolution, high flexibility, high throughput, and high reliability at economic cost. Powerful electron beam lithography (EBL) should never become a candidate for NGL because of its low througput despite its high resolution and high flexibility. Both extreme ultraviolet lithography (EUVL) and deep ultraviolet lithography (DUVL) have inherited the concept of traditional photolithography but its drawback is its high cost. In addition, recently near field lithography (NFL) using evanescent electromagnetic wave has emerged with the patterning resolution beyond optical diffraction limit. However, the constraint for the exposure within a near field range (roughly half of the wavelength) hinders its application in industrial lithography. On the other hand, reversal imprint lithography (RIL) is able to transfer patterned resist from one substrate to others without losing lithography quality. In this paper, we propose a hybrid lithography, by combing both near field lithography with reversal imprint technique for high resolution patterning with a good opportunity of wafer scale manufacture. This novel process is named as combined near field lithography with reversal imprint (CNR).

Figure 1 schematically depicts the basic concept of this CNR lithography. The mask plate with opaque metallic pattern on quartz wafer as shown in fig.1(a) can be produced by EBL. NFL is carried out on conventional resists exposed by UV lights from the backside of the mask plate (Fig.1 (b-c)). The patterned resist on top of the metallic pattern is then transferred to a target substrate such as glass wafer by the RIL process (fig 1(d-f)). The experiment results are shown in fig. 2, where both grating structure of 400 nm l/s and 500 nm diameter dot array structures are realized. The mask plates in fig. 2(a) and (c) are made by EBL on a quartz substrate with 20 nm Cr and 70 nm Au as the opaque metallic area. UVIII resist is spin coated on top of the mask plate and then exposed by a 250 nm UV light from the back side. After development in CD26 and rinse in DI water, the residual resist layer on top of the metal pattern is then transferred on to another glass substrate by reversal imprint lithography (RIL) as shown in fig. 2(b) and (d). This combined lithography possesses a number of advantages of high resolution, high flexibility, high throughput, large area capability and economic cost. By summary, we have successfully developed a combined near field lithography and reversal imprint technique. This CNR technique has the prospect to become next generation lithography for wafer scale patterning with high resolution and economic cost.

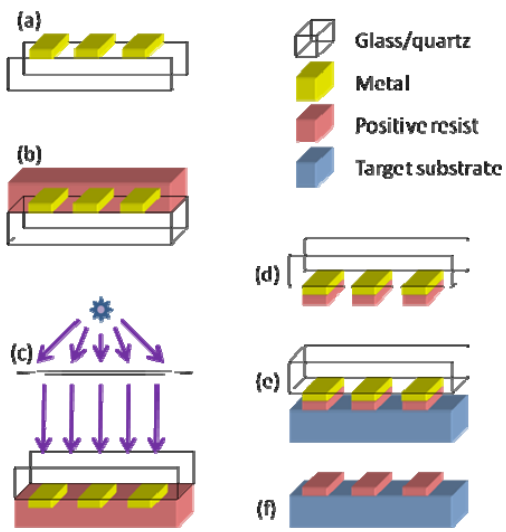

Figure 1. The schematic flow chart for the CNR technique: (a) preparation of mask plate with metal structures on transparent substrate; (b) spin coat positive resist on top; (c) UV exposure from backside; (d) development of resist; (e) transfer resist to target substrate using RIL; (f) pattern transferred to target substrate.

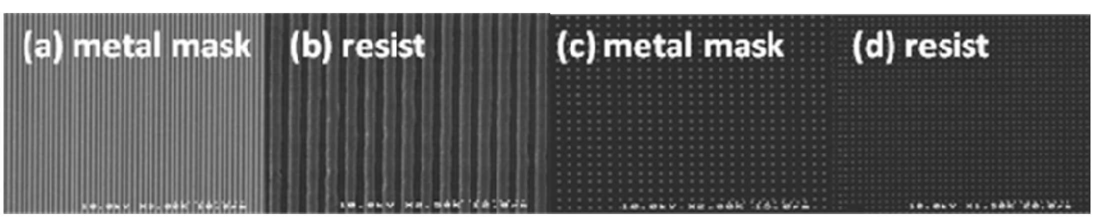

Figure 2. SEM photos of CNR lithography: metal mask plates ((a) and (c)) and transferred resist on the target glass substrate ((b) and (d))for the lithography. Structure in (a) and (b) grating with 400 nm l/s, in (c) and (d) is dot array with 500 nm diameter dot cells.