Combined Near-field lithography and reversal imprint for high resolution patterning in wafer scale

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The candidates for next generation lithography (NGL) for mass production should be capable of high resolution patterning (<30 nm) with high throughput, high flexibility and high reliability at economic cost. High resolution electron beam lithography (EBL) is highly unlikely to become the candidate for NGL because of its low throughput. Both extreme ultraviolet lithography (EUVL) and deep ultraviolet lithography (DUVL), being able to replicate in high volume, are prospective for becoming NGL, if the high cost for the facility kit and maintenance are endurable. Recently, near field lithography (NFL) using evanescent electromagnetic wave has emerged with the patterning resolution beyond optical diffraction limit[1]. However, due to the limitation of near field exposure, there is still a long way to go for this technique to be applied for conventional patterning in large area. On the other hand, reversal imprint lithography (RIL) has emerged, being able to transfer patterned resist from one substrate to others without losing lithography quality[2]. Based on the latest development in nanolithography, we propose a hybrid lithography, short named as CNR, by combing near field lithography with reversal imprint technique for high resolution patterning with a good opportunity of wafer scale manufacture.

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 remaining on the opaque metallic pattern is then transferred to a target substrate such as Si wafer by the RIL process (Fig 1(d-f)). In the development of this hybrid lithography, initial progress has been achieved. Figure 2 shows the mask plate used in the work, which is fabricated by nanoimprint lithography. In the NFL, a conventional PMMA resist is spin coated on the top of the mask plate, and

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[1] M.M. Alkaisi, R.J. Blaikie, and S.J. McNab, Microelectron. Eng. **53**, 237 (2000).
[2] W. Hu, B. Yang, C. Peng, and S. W. Pang, J. Vac. Sci. Technol. B **24**, 2225 (2006).

then exposed by a UV light. Fig 3 presents the patterned PMMA resist remaining on the metallic chiral pattern after a development in MIBK: IPA (1:3). This resist layer is then transferred on to the target substrate by the RIL process (the result is not presented in this abstract). 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.

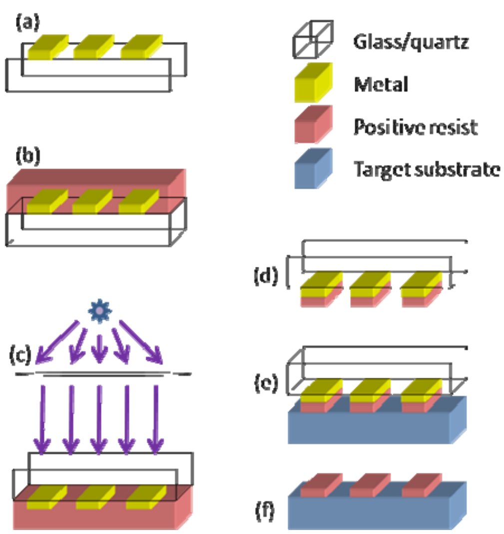

Figure 1. The schematic flow chart for the CNR technique: (a) preparation of mask plate with metal structures on transparent substrate; (b) spin coat positive resist on top; (c) UV exposure from backside; (d) development of resist; (e) transfer resist to target substrate using RIL; (f) pattern transferred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

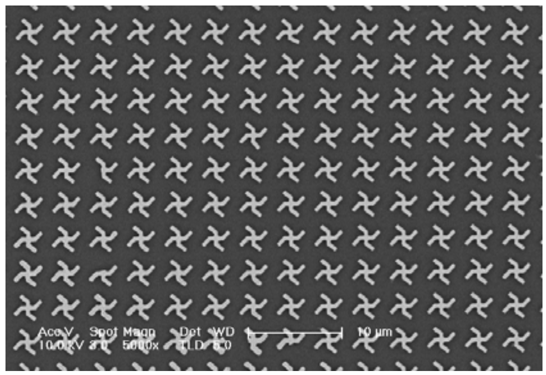

Figure 2. The mask plate with metallic chiral structures on quartz, fabricated by NIL.

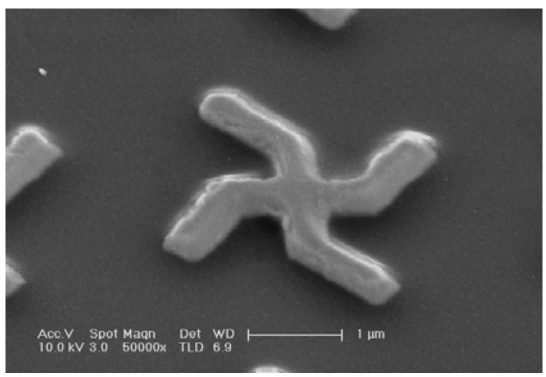

Figure 3. A thin layer of unexposed PMMA on top of the metal structure after near-field lithography is observed.