Estimation of diffusion lengths of acid and quencher in chemically-amplified resist on the basis of EUV exposure results

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Since extreme-ultraviolet lithography (EUVL) uses a much shorter wavelength than optical lithography does, optical proximity correction (OPC) for the patterns on EUVL masks should be simpler than that for advanced photomasks. However, resist blur increases the discrepancy between the shape of an aerial image and the printed resist pattern as patterns become smaller.[1] The main cause of resist blur might be the diffusion of the acid and the quencher in a chemically-amplified resist.[2] If their diffusion lengths are found to be quite large, resist blur correction (RBC) will be required for the patterns on EUVL masks. In this study, we estimated these lengths for a chemically-amplified resist by fitting the calculated shapes of resist pattern to EUV exposure results.

Several kinds of fine patterns, such as line patterns with a half pitch (hp) of 45 nm, were printed with the EUV micro exposure tool (MET) at the Lawrence Berkeley National Laboratory using the positive-tone chemically-amplified resist MET-1K (120 nm[t]). Then, the shapes of resist patterns calculated with the SOLID-EUV lithography simulator were fit to the shapes of printed patterns. Figure 1 shows the EUV exposure results for hp-45-nm patterns. Although the isolated line disappeared in the line-type pattern, the isolated space was resolved in the space-type pattern. A previous study reported that the diffusion length of the quencher was about ten times larger than that of the acid.[2] However, if that model were correct, the isolated space would also have disappeared, just as the isolated line did. Figure 2 shows the simulation results for hp-45-nm patterns, in which we used diffusion lengths of 40 nm for the acid and 30 nm for the quencher. In this case, the calculated shapes agree well with the experimental results for both types of patterns. Thus, it was found that, in MET-1K resist, the diffusion length of the acid was relatively large and that of the quencher was quite small.
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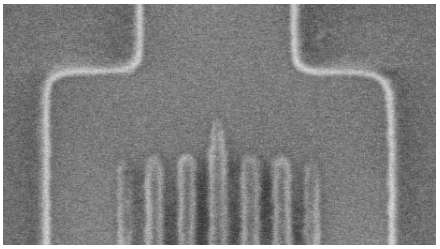
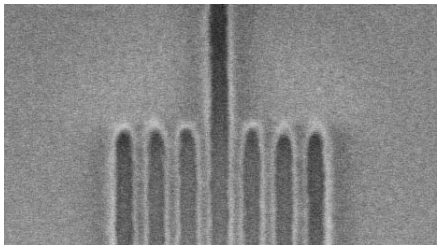
1 J. P. Cain, P. Naulleau, C. J. Spanos, *Proc. of SPIE*, **5751**, 1101 (2005).
2 H. Fukuda, K. Hattori, and T. Hagiwara, *Proc. of SPIE*, **4346**, 319 (2001).

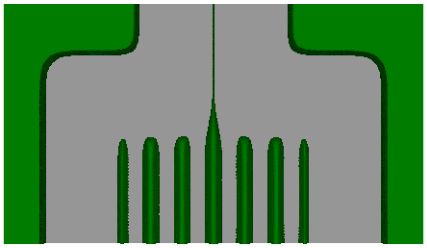


(a) Line-type pattern

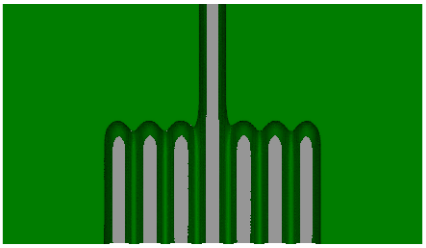


(b) Space-type pattern

Fig. 1. EUV exposure results for hp-45-nm resist patterns.



(a) Line-type pattern



(b) Space-type pattern

Fig. 2. Simulation results for hp-45-nm resist patterns.