Novel negative-tone molecular resist for EUV lithography

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The development of high-quality EUV resists is one of the critical issues in EUV lithography. Considering resist materials, conventional polymeric chemically amplified (CA) resists have reached their performance limit: The resolution is limited by acid diffusion, and the line edge roughness (LER) is too large due to the large molecules of resin and compositional non-uniformity. A promising solution is molecular resists. A large number of these resists, especially positive-tone resists have been investigated. Negative-tone resists, however, from the viewpoint of flare control and mask-blanks defects reduction for EUV lithography, should be considered and investigated more. Mr. Echigo reported the EUV patterning performance of a new chemically amplified negative-tone resist based on bis[bis(alkylhydroxyphenyl) alkyl] naphthalene (BPN) derivative [1]. It exhibits a high contrast, a resolution of 65 nm at an exposure dose of 40 mJ/cm^2.

In this work, we optimized material composition and process conditions of the new chemically amplified negative-tone resists based on BPN derivative (Fig. 1) and evaluated their EUV patterning performance and outgassing amount. Imaging experiments were carried out with a high-numerical-aperture (NA=0.3), small-field EUV exposure tool (HINA) [2]. The illumination system consists of two flat mirrors, and also a spherical mirror that focuses the image of the EUV light source on a point at the pupil of the projection optics. The light source was synchrotron radiation on the SBL-1 beamline of Super-ALIS at NTT. Outgassing evaluation from the resist films was carried out at an apparatus installed at the SBL-2 beamline of Super-ALIS [3]. With this advanced molecular resist, a resolution of less than 30 nm at an exposure dose of 18 mJ/cm^2 was achieved (Fig. 2). Moreover, the outgassing rate was almost as same as that of a conventional poly(4-hydroxy styrene)-based resist. In addition, negative-tone imaging mechanisms will be discussed. The authors would like to thank Mitsubishi Gas Chemical Company for preparing the resists.

1. M. Echigo, the 5th International EUV Symposium, 16-18 October, 2006, Barcelona.
2. H. Oizumi et al., Proc. SPIE Vol. **5751** (2005) 102.
3. H. Oizumi, et al., J. Photopolym. Sci. Technol., **20** (2007) 403.

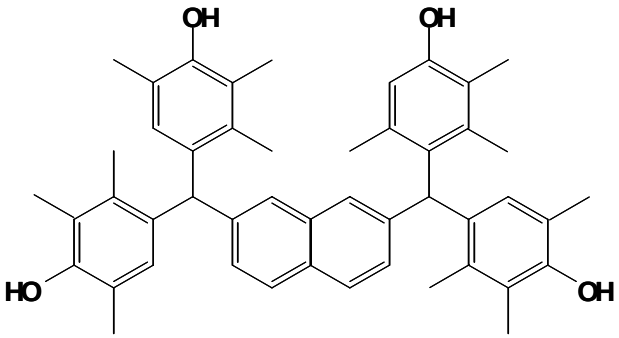

Figure 1. Chemical structure of bis[bis(alkylhydroxyphenyl) alkyl] naphthalene (BPN) derivative.

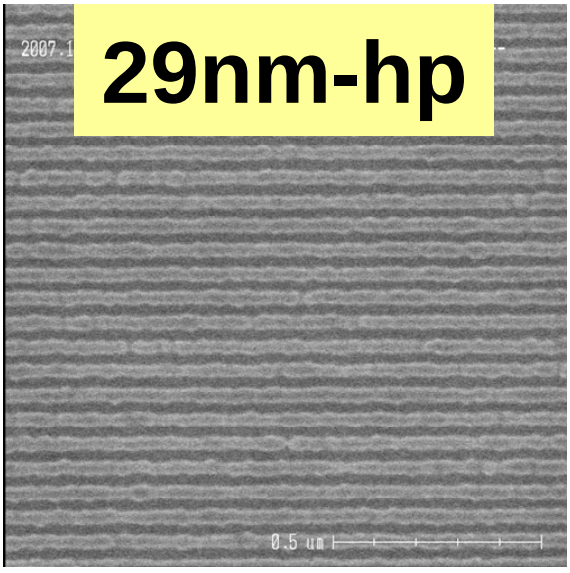

Figure 2. Dense lines with half pitch of 29 nm printed in a new chemically amplified negative-tone resist based on bis[bis(alkylhydroxyphenyl) alkyl] naphthalene (BPN) derivative. (hp = half pitch)