Dissolution characteristics of chemically amplified EUV resist

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Extreme ultraviolet (EUV) lithography is the strongest candidate to realize actual semiconductor device manufacturing below 32nm node. EUV resist is one of the most critical issues in its realization because no resist concurrently meets the targets of lithographic performance of resolution capability, sensitivity, and line width roughness (LWR). In order to improve the resist performance, it is important to understand reaction mechanisms of the resist pattern formation.

In this study, dissolution characteristics of the resist film into alkaline developer have been investigated in order to understand inherent resist characteristics and improve resist performance. Two types of chemically amplified EUV resists which are polyhydroxystyrene (PHS) based resist and molecular resist were used. Figure 1 shows chemical structure of (a) PHS resist and (b) molecular resist. The resist film thickness on silicon wafer is set as 60nm. EUV exposure was carried out by open-flame exposure tool with a stand-alone EUV source (EQ-10MR by Energetiq technology). Developer is aqueous tetra-methyl-ammonium hydroxide (TMAH) solution of 2.38 wt%. Dissolution rates were measured by resist development analyzer (RDA by Litho-tech Japan).

Figure 2 shows dissolution rate as a function of exposure dose for PHS and molecular resists. From this figure, dissolution parameters such as maximum dissolution rate (Rmax), minimum dissolution rate (Rmin) and slope of the dissolution curve (m) were obtained and summarized in Table 1. Rmax of both resists were almost the same, however Rmin of molecular resist is larger than that of molecular resist. These indicated that molecular resist can easily and smoothly dissolve into alkaline developer, thus it can minimize LWR of the resist pattern [1]. Furthermore, the slope m of molecular resist is much higher than that of PHS resist. This indicated that molecular resist has potential of higher resolution capability [2]. The detail analysis of dissolution reaction and lithographic performance evaluated by EUV small field exposure tool (SFET) will be presented at the conference [3].

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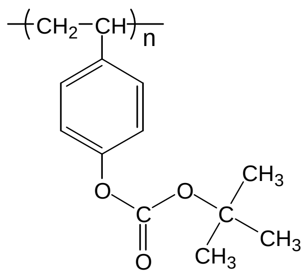
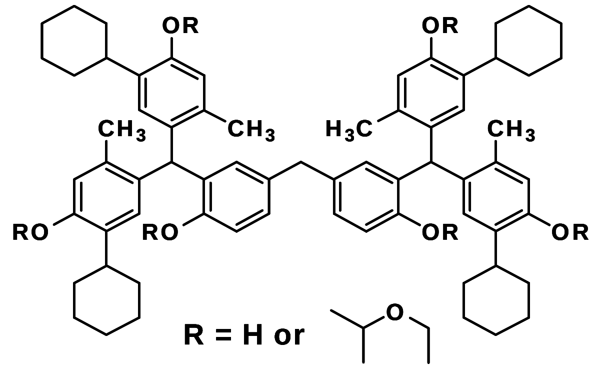
[2] T. Itani, H. Iwasaki, M. Fujimoto and K. Kasama, “Dissolution Kinetics Analysis for Chemically Amplified Deep Ultraviolet Resist”, Jpn. J. Appl. Phys., 33, 7005 (1994).
[3] D. Kawamura, S. Kobayashi, K. Kaneyama, J. Santillan, T. Itani, “Current status of EUV resist development in Selete”, RE-05, 2007 International EUVL Symposium (2007).



(a) PHS resist



(b) Molecular resist

Figure 1. Chemical structure of (a) PHS resist and (b) molecular resist.

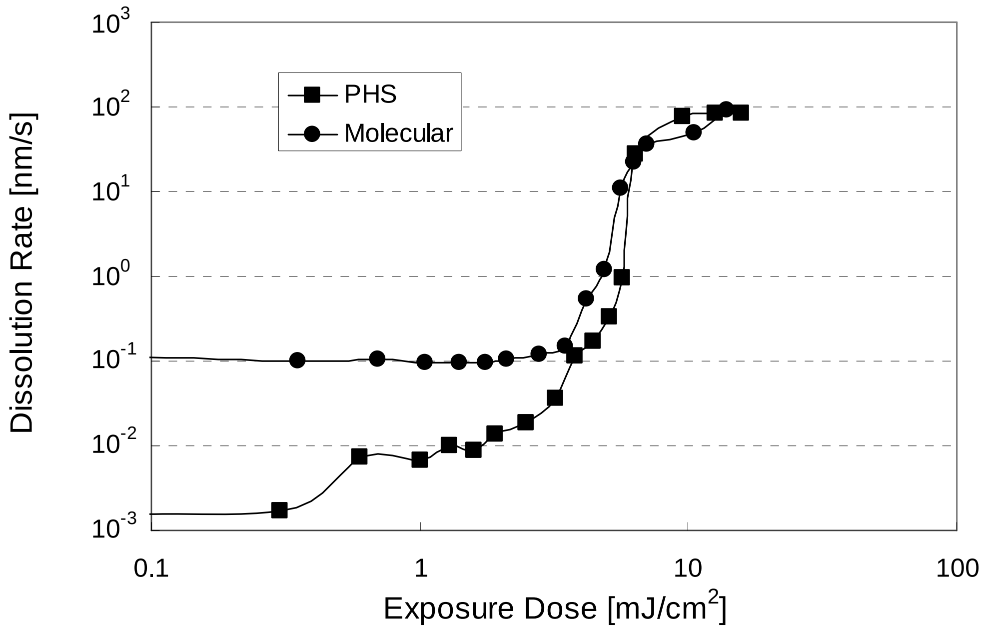


Figure 2. Dissolution rate curve for PHS and molecular resists.

Table 1. Dissolution parameters of PHS and molecular resist.

Resist type	PHS resist	Molecular resist
Rmax (nm/s)	8.5×10^{1}	9.3×10^{1}
Rmin (nm/s)	1.7×10^{-3}	1.0×10^{-1}
Slope m	2.5	7.0