Dissolution characteristics of molecular resists for EUV lithography

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Line-edge or line-width roughness (LER/LWR) is one of critical problems to be resolved for EUV lithography. The origin of LER/LWR can be classified to resist processes and materials. The development process of resist in alkaline developer film should be primary point. The fluctuation in dissolution rates of resist films enhances the LER/LWR in the development process. The molecular resists are proposed to reduce the LER/LWR because of their smaller sizes of matrix molecules compared with the larger size of the polymer resist. Therefore we evaluated the dissolution behavior of molecular resist by quartz-crystal-microbalance (QCM) method and surface roughness by atomic force microscope (AFM) to study the characteristics of molecular resist.

The evaluated molecular resists was composed of base materials of polyphenols, photoacid generators, and ammines. Polymer resist of polyhydroxystyrene was used as a reference. Both samples were exposed by the EUV light and the dissolution behaviors were observed by QCM method (Fig. 1). Molecular resist (a) showed smaller swelling during the development, though the polymer resist (b) showed the larger swelling at the low irradiation doses. This dissolution characteristic of molecular resists was preferable to polymer resists from the view points of the reduction of LER/LWR and the high resolution capability. The roughness of resist surface after the development was measured by AFM. Both resists showed the same dependence on the irradiation dose that the surface roughness increases with increasing the irradiation dose as shown in Fig. 2.
The FT-IR spectra and LER values of delineated patterns will be shown and discussed in relation to the dissolution behavior and surface roughness data at the conference.

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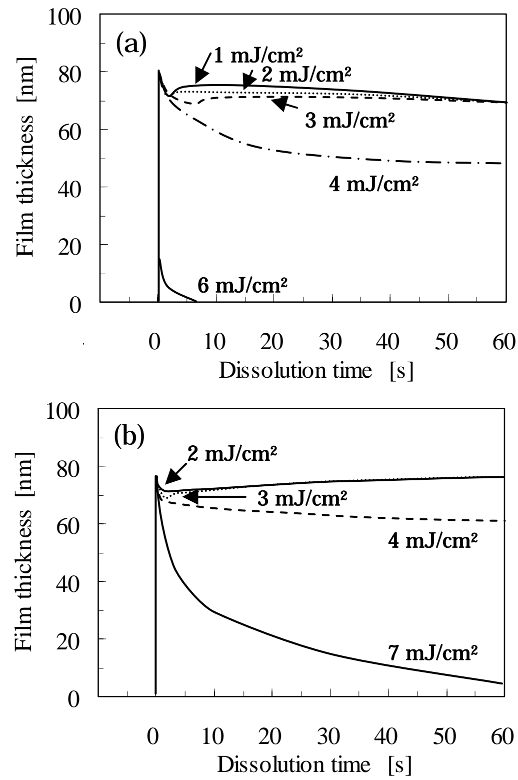

Figure 1. Irradiation-dose dependence of dissolution behaviors of molecular resist (a) and polymer resist (b) by QCM.

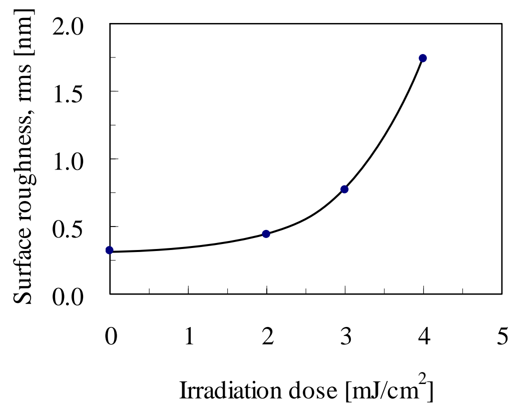

Figure 2. Irradiation-dose dependence of surface roughness of polymer resist film measured by AFM.