The Study of Low Molecular-Weight Resist Materials (LMR) for Microlithography

Yoshio Yamashita

The quest for high performance in Si and GaAs semiconductor devices has pushed lithography into sub-half-micron regime. In order to obtain higher resolution, the studies on resist materials and resist processes have become much more important. This paper deals with low molecular-weight resist (LMR) and its applications to resist processes.

LMR is a naphthoquinone-diazide sulfonic acid ester of a novolac resin and an oligomer resist whose molecular weight is about 1200. LMR is negative working upon irradiation with deep UV light and forms an overhang structure with a single development step. The sensitivity of LMR is 20 mJ/cm² and 0.2 μm wide spaces are clearly resolved. By use of LMR, a simple and reliable lift-off process has been realized. The mechanism of the insolubilization in the developer on deep UV irradiation reveals an increase in the average molecular weight (Mw). The increase in Mw is due to the crosslinking reaction of the benzylic methylene group of the novolac resin. LMR-UV has also been developed as a resist for UV projection exposure system. It resolves 0.3 μm patterns and forms an overhang profiles. LMR and LMR-UV are being used in the manufacturing processes of GaAs-IC and SAW filter devices. Novel silicon-containing resists, SCMR (Silylated Clay Minerals Resist) and CMPR (Clay Minerals Positive Resist) have been developed as negative and positive resists for E-beam application. These resists were synthesized by the reaction of the silica plate of chrysotile with organochlorosilane. They have much higher oxygen plasma etching resistance and thermal stability than those of conventional Si-containing resists. CEL (Contrast Enhanced Lithography) and PCM (Portable Conformable Masking) methods are known as high resolution processes. To improve these processes, LMR and modified LMR have been applied to these methods and a simple CEL process and a new PCM process with high dry etching resistance have been realized.