NOVEL ALICYCLIC OLEFIN POLYMERS FOR MUTI-WAVELEGTHS PHOTO RESISTS

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After a lot of research and development efforts, KrF DUV (λ=248 nm) lithography has been successfully introduced into high volume semiconductor manufacturing for 180 nm applications and is being pushed to its limit down to 150 nm regime and even below. ArF DUV (λ=193 nm) lithography is rapidly emerging after the 248 nm lithography because of the demand for further resolution improvement and wider DOF (Depth Of Focus). However, the 193 nm lithography requires innovative development in various areas, such as laser sources, resist chemistry, and optics materials. A considerable progress has been made for the 193 nm lithography recently. ArF excimer laser sources with high power and ArF resist with the high resolution, large DOF, good adhesion, and good etch resistance have been demonstrated. ArF optics with a new material (CaF_2) and new multi-coating lenses to reduce lenses damage have been demonstrated.

We had developed several alternating alicyclic photoresists based on copolymers of cycloolefins with maleic anhydride for a 193-nm lithography[1,2]. We have synthesized resin, poly (2-hydroxyethyl 5-norbornene-2-carboxylate/t-butyl 5-norbornene-2-carboxylate/5-norbonene 2-carboxylate/ Maleic anhydride). Also, we have newly developed a novel multi-functional monomer. Application of this monomer also allows us to introduce another unit to further improve its etch resistance. Furthermore, our novel resist containing this multi-functional monomer exhibits an excellent adhesion to Si substrate, an improved CD linearity, a high sensitivity, a good contrast, and a high synthetic yield. A 0.12 ㎛ L/S pattern was successfully defined at 14 mJ/cm^2 by using a BIM(Binary Intensity Mask) with an off-axis illumination and a 2.38wt% TMAH aqueous solution as a developer (Fig.1). More detailed lithographic performances such as resolution limit using a phase shift mask, EL, DOF, and etch resistance will be presented. And these alicyclic olefin polmers has been implemented in KrF lithography without any modifications. Fig. 2 demonstrated 0.16 ㎛ L/S patterns (λ=248 nm, NA=0.6). Also, a novel copoymer with alicyclic moieties for an E-beam resist has been developed with optimizing PAG (Photo Acid Generator). We obtained 80 nm L/S patterns at 14 uc/cm^2 with an HL-800D electron beam lithography (Fig.3). We have been demonstrated the high lithographic performance with a novel alicylic olefin copolymers with the various wavelengths (λ=248 nm, 193nm, E-beam). These copolymers can be a strong candidate for the next generation photo resist materials in terms of the very high lithographic performance and lower cost.

1. J. C. Jung, C. K. Bok, and K. H. Baik, *Proc.SPIE 3333, 11* (1998)

2. J. C. Jung, C. K. Bok, and K. H. Baik, *J. Photopolym. Sci. Technol.*, **10**, 529 (1998)