Deep Ultraviolet Photolithography Capability of ZEP520A Electron Beam Resist for Mix and Match Lithography

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ZEP520A is a widely used high resolution electron beam resist produced by Zeon Chemicals. ZEP520A is a positive resist which is used because of its high resolution, plasma etching performance, and moderate sensitivity. However, electron beam lithography is characteristically a slow process overall. Since electron beam lithography is only necessary for deep submicron lithography and writing time is directly dependent on exposure area, it makes sense to split writing jobs into two parts. One part contains the deep submicron patterns for electron beam lithography and the other part contains micron sized features and larger for deep ultraviolet photolithography. Such an approach is typically called mix and match lithography. It is possible to use two separate resists, however, the process is greatly simplified if only one resist is used which can be patterned by both lithography types. The ZEP520A technical report mentions that the resist is also sensitive to DUV exposure, but no data is presented. Furthermore, to this author's knowledge, to date, no information has been published on the DUV lithography capability of ZEP520A.

This paper reports on the deep UV patterning capability of ZEP520A. The resist was exposed at 240nm wavelength using a Karl Suss MA6 Mask Aligner. The resist had a critical dose of 4000 mJ/cm2. The mask aligner had a power output of 6mW/cm2 thus exposures took 11 minutes, which although relatively long for photolithography, can be a big time savings compared to EBL. At 100kV and 2nA beam current, it takes over 27 hours to write a 1 cm^2 area in ZEP520 with a critical dose of 200uC/cm^2. Thus, the potential for time savings is significant, depending on the total pattern area to be exposed.

Furthermore, submicron resolution was achieved with DUV lithography as 0.37um lines were patterned with a pitch of 0.8um using n-Amyl Acetate developer for 2min at 20C. Other developers were examined and compared, including xylene (o,m,p mixed), o-xylene, acetone, and a mixture of methyl ethyl ketone and methyl isobutyl ketone. The absorbance and index of refraction of ZEP520A were obtained pre and post exposure using a Woolam V.A.S.E. Ellipsometer from 200 to 1000nm wavelengths and a mechanism for exposure is investigated.

In addition, a nanometer scale pattern using EBL was successfully aligned to a large micron size photolithography pattern in ZEP520A and was simultaneously developed in a single step with n-amyl acetate for 2 minutes.

This paper demonstrates for the first time that ZEP520A can be exposed by DUV photolithography and is useful for mix and match lithography schemes.

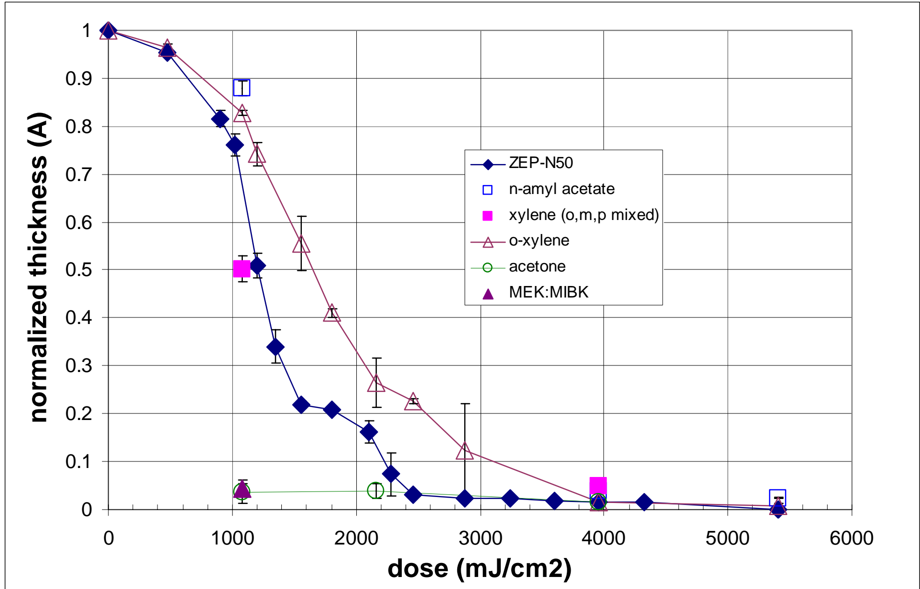

Figure 1: Contrast curves for various developers with 2min immersion

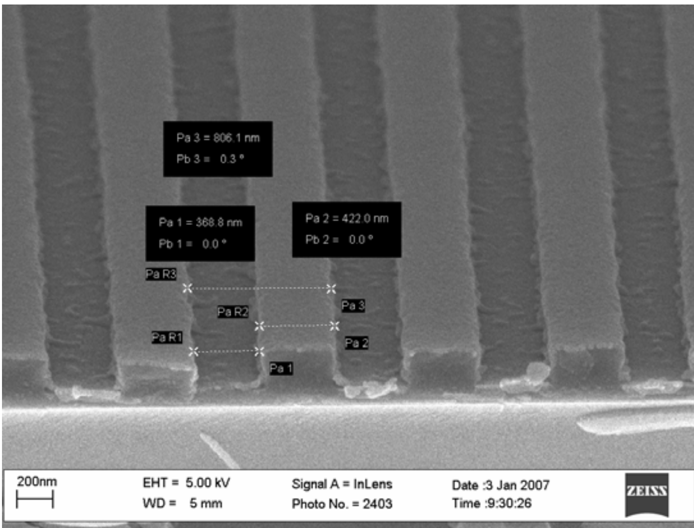

Figure 2: 240nm DUV exposed 370nm lines at 800nm pitch

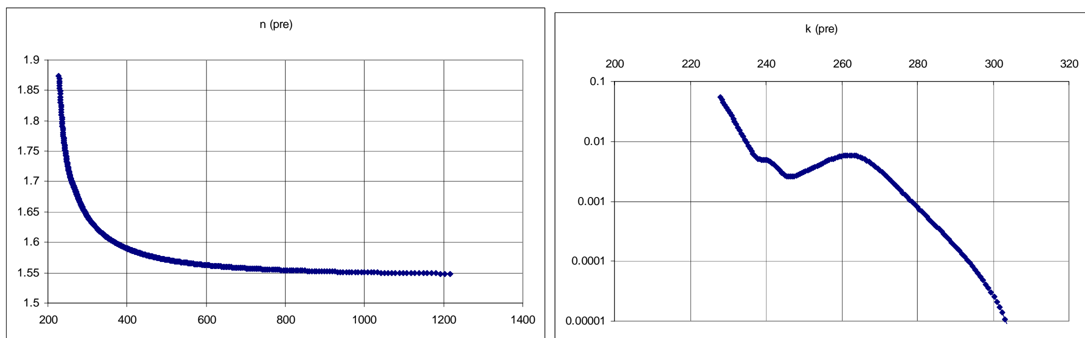

Figure 3: Index of refraction and absorbance pre 240nm exposure