UVC Hybrid Lithography on Electron-Beam Resists

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Novel UVC sources are emerging due to their virucidal action. Sources emitting at wavelengths relevant for microfabrication have been commercialized recently. Some sources tailored for the SARS-COV2 virus target the 220 nm wavelength. This wavelength range is very attractive for high-resolution photolithography on PMMA, as well as other electron beam resists, due to its high-absorption in that range. Direct hard contact photolithography of PMMA enables mix-and-matched electron beam lithography, as previously shown for PMMA,[1] with sub-micron resolutions. Importantly, it allows the uniform large area patterning for tiling around electron-beam written arrays for homogenous etching, for example.

In this work, we report on experiments of integration of electron-beam lithography with photolithography using ultraviolet irradiation for electron beam resists not sensitive to DUV@248 nm. Exposures of resists were conducted at 220 nm for ultraviolet irradiation through a mask. Different sources of UVC light were used to test different resist responses. For resolution tests, a contact aligner tool with a 500 W Hg-Xe lamp and a 220 nm filter was used, with 2 mW/cm^2 incident on the wafer. The exposure times depend on resist investigated.

Results for the contrast curve for a photolithographic process of PMMA-like films on relevant developers typically used in electron-beam lithography with different light sources will be presented. Shown in Fig.1 is the contrast curves for optical irradiation using an ABM tool with 2 mW/cm^2 @220 nm, for PMMA, MMA and ZEP520A electron beam resists. The x-axis units are in seconds. Fig.2 shows the resulting exposure with UVC 220 nm through a standard 5" Cr mask with patterns as small as 500 nm nominally on 950K PMMA exposed for 1000s and developed in MIBK:IPA (1:1) for 60s. We intend to present further results with masks produced using electron beam lithography and dry-etching of Cr for lower dimensions.

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[1] Rooks, M.J., Wind, S., McEuen, P.L., & Prober, D.E. (1987). Fabrication of 30-nm-scale structures for electron transport studies using a polymethylmethacrylate bilayer resist. *Journal of Vacuum Science & Technology B, 5*, 318-321.

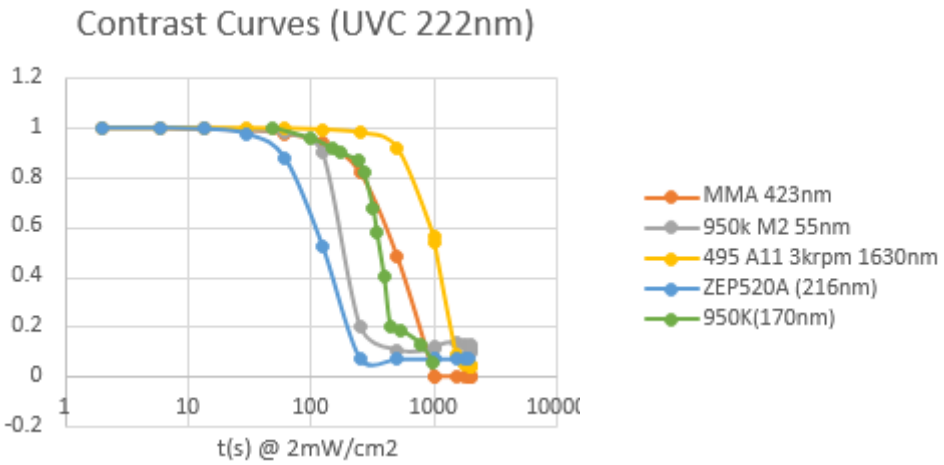

Figure 1: Contrast curve for optical irradiation at 220 nm wavelength for PMMA, MMAA and ZEP520A films on silicon. Starting thicknesses are shown in legend (color online). Normalized thickness after development in MIBK:IPA (1:1) for 60s.

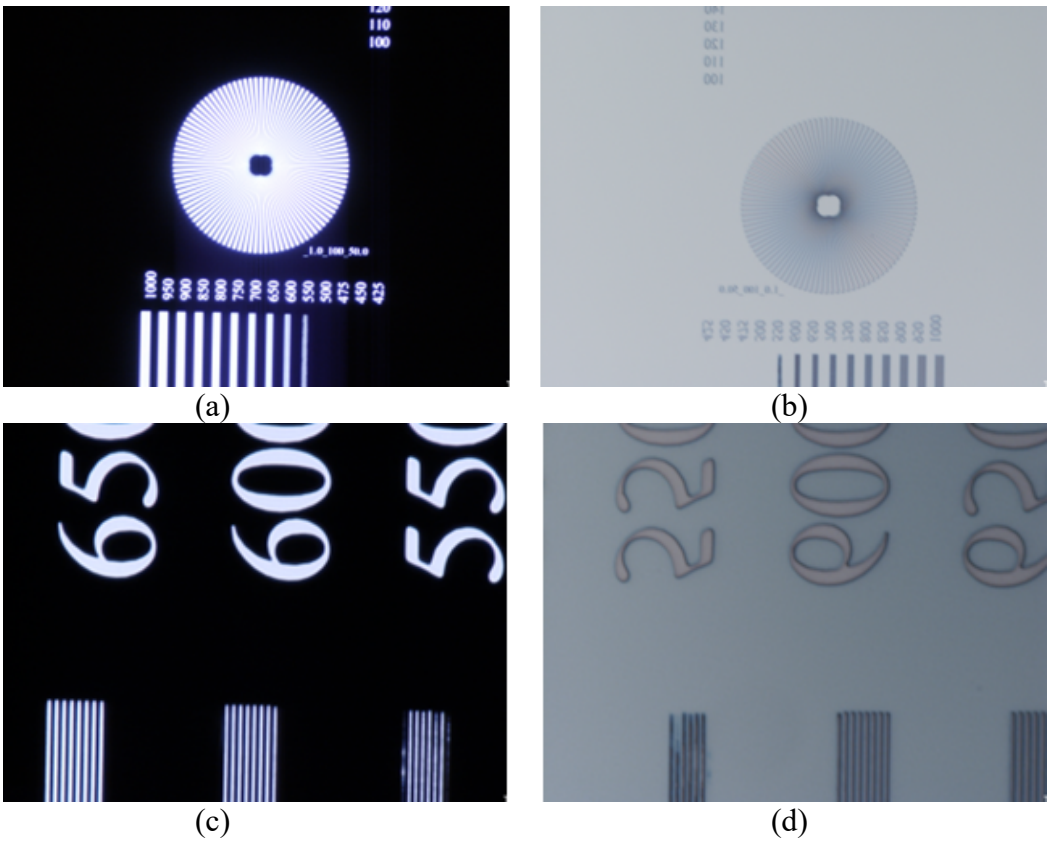

Figure 2: (a,c) Cr mask of test pattern written by DWL2000 direct laser write tool and wet etch; (b,d) UVC photolithography on 100nm thick PMMA, note the mirror image is obtained.