Pattern Noise in Contact Printing after Pattern Transfer

Marshal Miller*, A. R. Neureuther, W. J. Poppe
UC Berkeley, 271 Cory Hall, Berkeley CA 94704
B. Harteneck, E. Anderson
LBNL, Berkley CA 94720

Pattern Noise in small contact printing is characterized through top view SEMs of contact arrays exposed in a variety of resists on several substrates. Pattern noise is the variability in a set of identically printed patterns under the same exposure conditions. A new set of experiments were run to test the effects of pattern transfer and imaging on the observed noise. Exposures were run with KRS and PMMA on bare silicon wafers and wafers coated with silicon oxide of varying thicknesses (from 15nm to 60nm). Different combinations of wet KOH and dry plasma etching were used to transfer the contact hole patterns into the Si and SiO_2. SEMs of the contact holes in oxide were much cleaner and easier to process (Fig 2). Pattern noise was still present, which shows that the pattern noise is not an artifact of the SEM process. These effects still remain through the etching process, which shows that this noise is a problem that must be dealt with. In addition, tests were made using a chrome coat in an attempt to enhance image contrast, but preliminary results did not show a significant improvement.

A matrix of 391 contacts, 17x23 (dictated by the dimensions of the SEM display 768x1024), was printed at 100KeV on the LBNL nano-writer. The doses range from 28uC/cm^2 for chemically amplified resists to 5000uC/cm^2 for high dose resists such as PMMA. SEM images were taken of the exposed arrays and DipImage, a Matlab toolbox, was used for image processing. Previous experiments have looked at pattern noise in KRS, TOK, PMMA, and HSQ by looking at top down SEM images of the resist (Fig 1). Pattern noise was present in all of the resists, with statistics showing that variation observed is due to less than 40 effective events for all resists other than HSQ.[1] This implies that there are resist effects causing greater noise than expected in the printing process. Out gassing was explored as a possible cause of pattern noise, but top coat experiments did not eliminate the noise.

Lastly, new patterns were exposed in addition to the standard 17x23 contact arrays. Non-square contacts, lines of varying width and spacing, and checkerboard patterns were designed to look at the dependence of the pattern noise on size, shape, and proximity effects. Statistical analysis comparing these effects will be presented.

[1] Miller M. A., Neureuther A. R., *EIPBN*, 2006.

*e-mail: mamillr@eecs.berkeley.edu

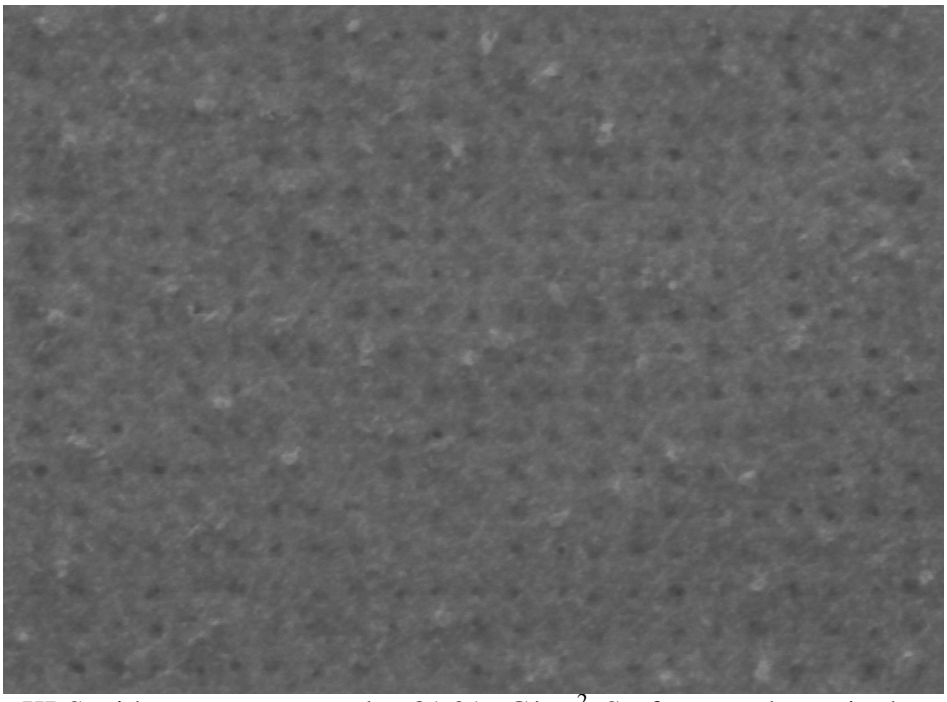

Figure 1: KRS with top coat exposed at 81.91 uC/cm^2. Surface roughness in the resist made data acquisition and analysis more difficult and added noise. New techniques were used to work around these effects.

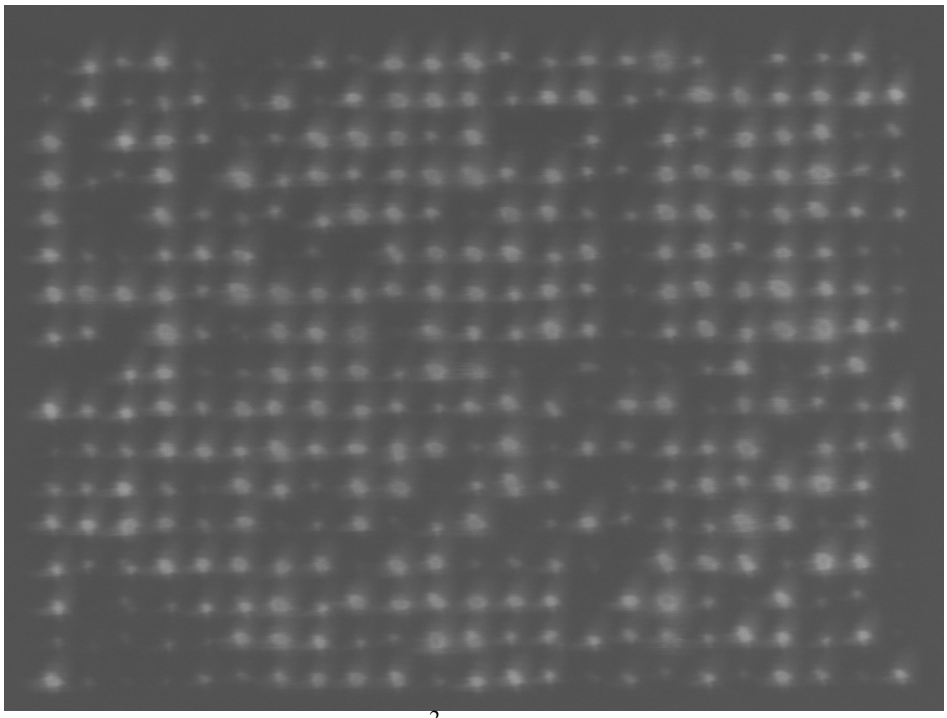

Figure 2: PMMA exposed at 3192 uC/cm^2 on a Si substrate with 55 nm of oxide, which was patterned using an anisotropic plasma etch. The resist was stripped away using piranha, leaving only the patterned oxide on the silicon substrate. Pattern noise is still prevalent, but the image is shows higher contrast between the pattern and the background, with less surface noise.