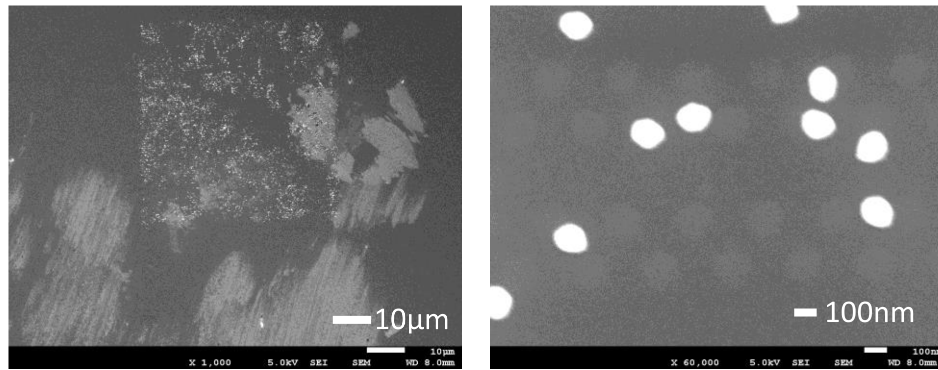
Metal Free Adhesion of Au onto Si Native Oxide

G. Lopez, M. Metzler, S. Wood, C. Elliott, G. Kim
Singh Center for Nanotechnology, University of Pennsylvania
3205 Walnut St, Philadelphia, PA 19104

A. Thompson
DisChem, Inc., 17295 Boot Jack Rd, Suite A, PO Box 267, Ridgway, PA 15853

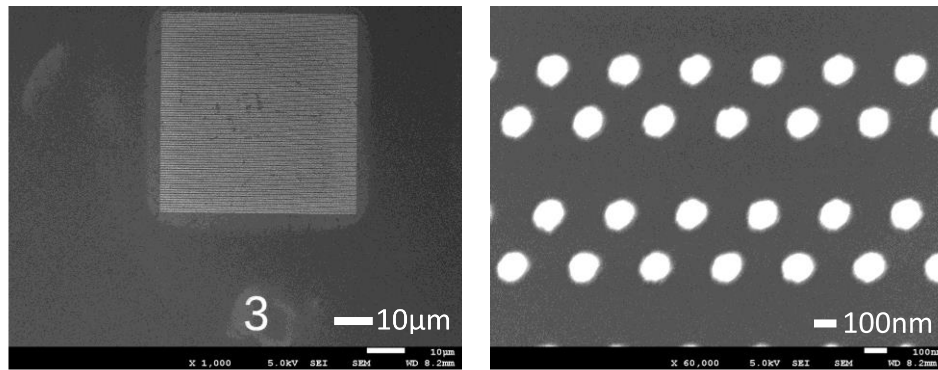
The adhesion of gold to an Si substrate in the absence of a seed layer, due to a lack of compatibility with a particular process, device constraints or basic redundancy, is an established and continuing difficulty in processing. As is widely known, Au adhesion is hindered by the oxygen present in the native oxide resting on the Si substrate. It has been common practice to put a seed layer like Cr or Ti prior to Au deposition to prevent delamination of the Au thin film. This paper addresses this problem through an examination of the adhesion promotion properties of SURPASS 4000 for 100nm Au dots at various pitches. The patterns were exposed on 300nm of ZEP520A on an Si substrate using an Elionix ELS-7500EX 50kV electron beam lithography tool at 1nA with a 60um final aperture and a 20nm beam step size. Samples were developed using o-xylene for 70 seconds at 21˚C, then soaked in IPA at 21˚C for 30 seconds followed by a N_2 blow dry. Before the deposition of Au, each of three samples received varying treatments for adhesion. The first sample was left untreated, whereas the second sample had a 10nm Cr seed layer e-beam evaporated at 2 Å/sec onto the surface. Lastly, the third sample was soaked in SURPASS 4000 for 2 minutes followed by an IPA rinse and N_2 blow dry. Using a load-locked Kurt J. Lesker Co. Model PVD75 with a 4 pocket e-beam hearth, samples were mounted to a carrier platen to evaporate 40nm Au (2.5 Å/sec) at a base pressure of 1 e-7 Torr. Metal lift-off was performed using 1165 stripper at 60˚C for 10 minutes.

Images following lift-off of the control, Cr and SURPASS 4000 treated samples are respectively shown in Figures 1, 2 and 3. As indicated in Figure 1, the lack of adhesion promotion treatment results in an expected delamination of Au from the substrate. In contrast, Figure 2 shows the expected adhesion of Au in the presence of a Cr seed layer. Most importantly for the claims of this paper, Figure 3 indicates the adhesion of Au on Si in the presence of a SURPASS 4000 treatment, absent a metal seed layer. In the text that follows, we will discuss contact angle measurements and show additional sub-100nm structures that have been enabled as a result of this finding.



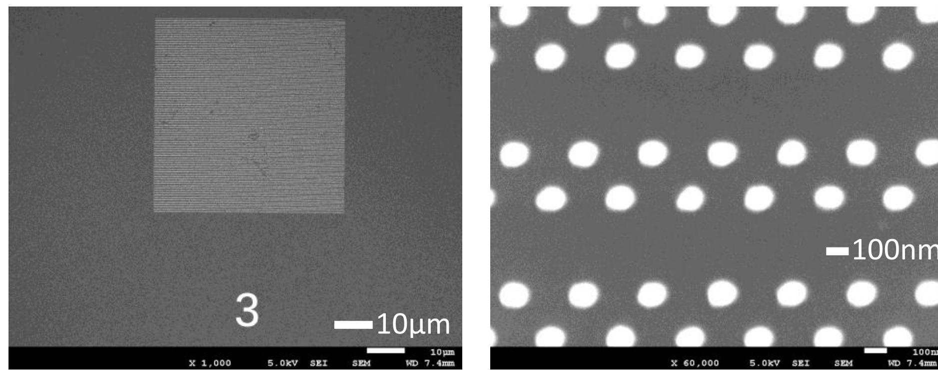
(a) *(b)*

Figure 1: Control Sample: The control sample received no adhesion promotion treatment. An overview of the sample (a) and a zoom at the center (b) illustrate the poor adhesion of Au onto Si.



(a) *(b)*

Figure 2: Cr Sample: With a Cr seed layer, Au adhesion is evident. An overview of the sample (a) and a zoom at the center (b) illustrate the expected adhesion of Au onto Si.



(a) *(b)*

Figure 3: SURPASS 4000 Sample: Using SURPASS 4000, Au adhesion onto Si is also apparent. An overview of the sample (a) and a zoom at the center (b) illustrate the adhesion of Au onto Si without the use of an additional metal seed layer.