Beam induced deposition of metal using a Helium Ion Microscope

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Beam induced deposition and etching of materials is an important nanofabrication technique with applications in many scientific and engineering disciplines such as material science, semiconductor processing, basic physics research, and NEMS, just to name a few. A specific application of great importance to the electronics industry is that of circuit edit (CE) in which materials must be both deposited and removed with nanometer level positional accuracy, and the materials properties of the deposited films such as conductivity, resistivity, etc, must be well controlled. Traditionally this application has been performed by the use of gallium focused ion beams. Gallium ion beam technology is facing increasing performance limitations for the CE application. Gallium is electrically active, and is a p-type dopant within silicon. Gallium's metallic properties also likely place upper limits on the resistivity of gallium deposited insulator films and affect the dielectric constant. Alternative technologies for depositing and etching materials for the CE application may significantly improve the effectiveness of the CE application.

Helium ion microscopy is now a demonstrated and a practical technology that possesses the resolution and beam currents necessary to perform circuit edit applications. Due to helium's electrical properties and sample interaction characteristics relative to gallium, it is likely that the properties of deposited films will be different than those produced using gallium FIB technology. However, as discussed in the excellent review article by Utke[1] et al., there is at this date very little literature discussing the use of helium beams for beam induced chemistry, or characterization of the resulting films. In this paper we present initial results regarding the deposition of metal using a helium ion microscope and gaseous metal precursors. Within this work a Carl Zeiss ORION™ helium ion microscope was used along with an OmniGIS unit to deposit metals while exploring a variety of controllable parameters such as dose, beam voltage, and substrate bias. Initial results show that deposition takes place easily.

1 I. Utke, P. Hoffmann, and J. Melngailis, J. Vac. Sci. Technol. B 26(4), 1197 (2008).

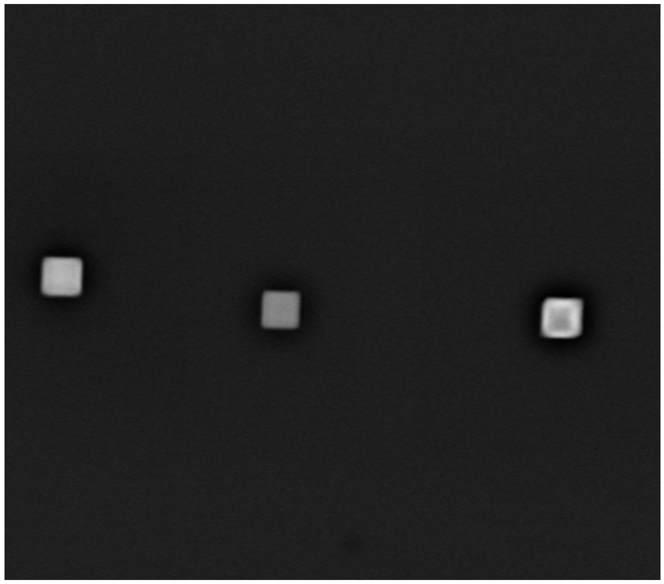

FIG. 1. Backscatter electron image of deposited tungsten on Si obtained using helium ion microscope and tungsten precursor. Each deposited pad is approximately 1.5x1.5 um.

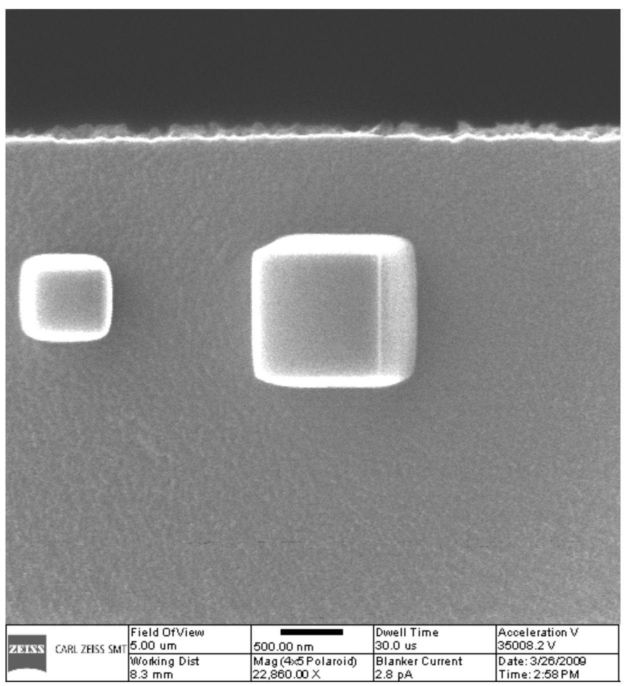

FIG. 2. Secondary electron image of deposits obtained using platinum precursor on chromium photomask.