Enhanced purity via laser assisted electron beam induced deposition of tungsten

N.A. Roberts [1,2], C.M. Gonzalez [2], J.D. Fowlkes [3], C.D. Hartfield [1], T.M. Moore [1] and P.D. Rack [2,3]

1 Omniprobe, Inc. an Oxford Instruments Company, Dallas, TX 75238
2 Department of Materials Science and Engineering, University of Tennessee, Knoxville, TN 37996
3 Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, Oak Ridge, TN 37831

Laser assisted electron beam induced deposition is a direct-write nanolithography technique with a synchronized in situ thermally stimulated purification step. After each electron beam induced deposition process a laser pulse is triggered, rapidly heating the substrate at the deposit to thermally desorb non-volatile dissociation by-products. The substrate is then allowed to cool and fresh precursor to adsorb onto the surface before the next electron beam induced deposition cycle begins. Laser assisted electron beam induced deposition has been demonstrated previously with platinum from trimethyl(methylcyclopentadienyl)platinum(IV) ($MeCpPt^{IV}Me_3$) and showed significant purification[1]. In this work, the same procedure is used to produce high purity and low resistivity tungsten from tungsten hexacarbonyl ($W(CO)_6$). Figure 1 shows recent results of the purity of laser assisted electron beam induced deposition of tungsten from energy dispersive x-ray spectroscopy. Figure 2 shows resistivity data of laser assisted electron beam induced deposits of tungsten from four point probe measurements with a minimum occurring at 39 μΩ-cm, which is less than one order of magnitude greater than pure tungsten of ~5.6 μΩ-cm.

[1] N. A. Roberts, J. D. Fowlkes, G. A. Magel, and P. D. Rack, "Enhanced material purity and resolution via synchronized laser assisted electron beam induced deposition of platinum," Nanoscale **5**, 408-415 (2013).

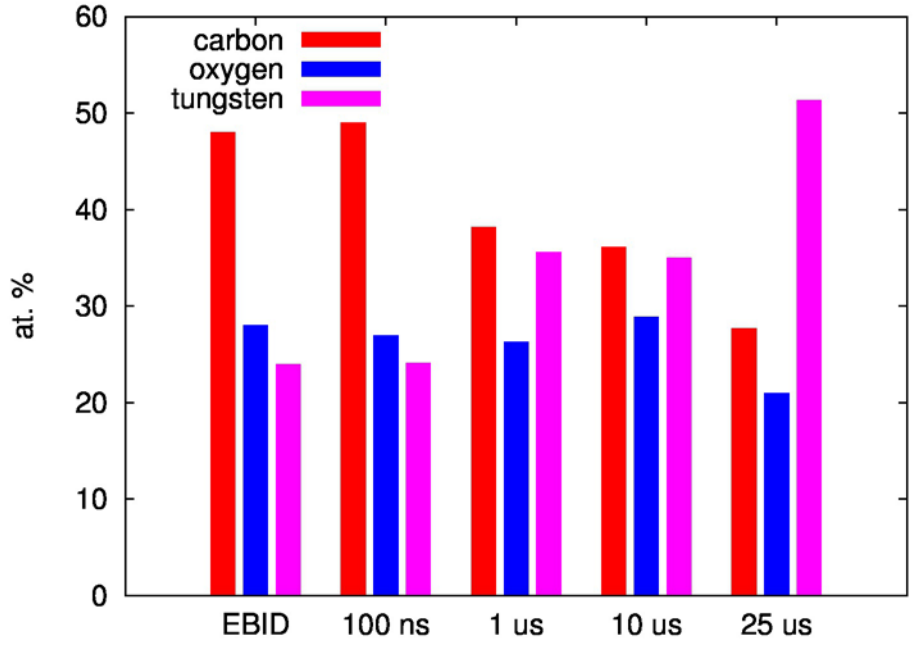

Figure 1. Composition of electron beam induced tungsten deposits with and without the laser assist process at various laser pulse widths.

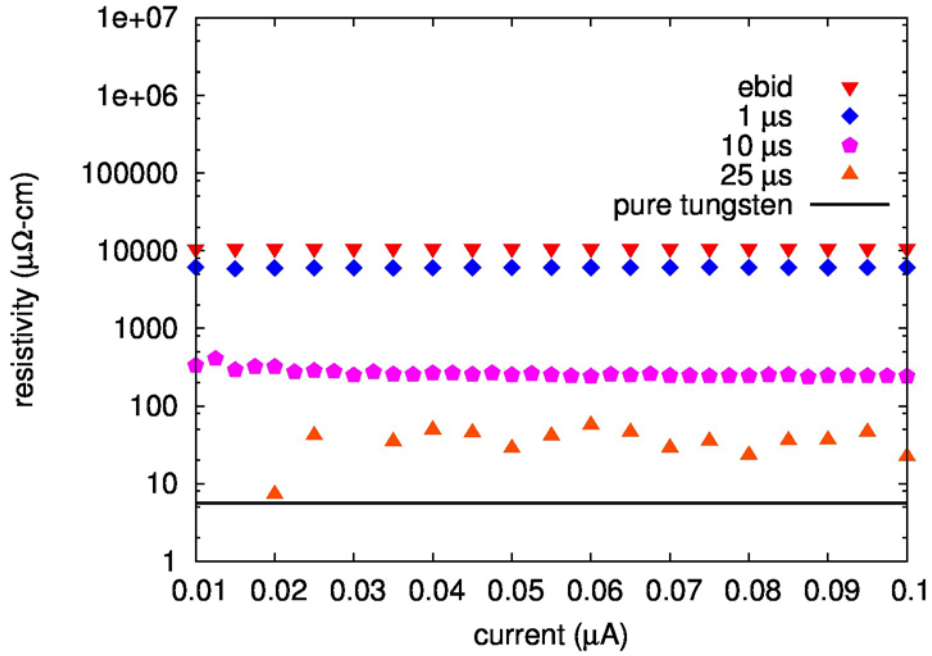

Figure 2. Resistivitiy as a function of the force current of electron beam induced tungsten deposits with and without the laser assist process at various laser pulse widths.