SUPERCONDUCTIVE TITANIUM NITRIDE THIN FILMS AND DEVICES PRODUCED BY THE PULSED LASER DEPOSITION TECHNIQUE

Andrii Torgovkin[1], Saumyadip Chaudhuri[1], Jari Malm[1], Timo Sajavaara[2], Manu Lahtinen[3] and Ilari Maasilta[1]

[1] Nanoscience Center, Department of Physics, University of Jyväskylä, P.O. Box 35, FIN-40014 University of Jyväskylä, Finland
[2] Accelerator Laboratory, Department of Physics, University of Jyväskylä, P.O. Box 35, FIN-40014 University of Jyväskylä, Finland
[3] Laboratory of Inorganic and Analytical Chemistry, Department of Chemistry, University of Jyväskylä, P.O. Box 35, FIN-40014 University of Jyväskylä, Finland
email: andrii.a.torgovkin@jyu.fi

Recently, titanium nitride (TiN_x) has attracted researchers' attention as a high quality superconductor. It has composition dependent properties, with a transition temperature (T_C) possibly extending up to 6 K in the best cases. We routinely deposit superconducting TiN_x films using the pulsed laser deposition (PLD) technique on a variety of substrates: silicon, silicon nitride, sapphire and magnesium oxide. In this work, we also report fabrication of tunnel junction devices from these films and measurement of their characteristics.

Superconductive transition temperatures of our films were found to depend on different factors, such as the substrate type and the film thickness, as well as the gas pressure in the deposition chamber. We found that the subsequent in-situ vacuum annealing of the freshly deposited films improves the T_C and the resistivity of the films. We present an investigation of the composition and the nanoscale structure of the films.

Studies of topography using atomic force and scanning electron microscopy revealed smooth and uniform surfaces of the films. X-ray diffraction studies showed that the TiN films on MgO were epitaxial in nature, while films grown on sapphire and silicon nitride were polycrystalline. The composition, determined by time-of-flight elastic recoil detection analysis, has shown good stoichiometry of the films with highest T_C (up to 3.82K). Charge carrier density was also determined from the measured value of the Hall coefficient for some films.

Tunnel junction devices were fabricated from TiN films deposited on several substrates, using electron beam lithography and shadow angle evaporation techniques. The Cu-AlO_x-TiN_x NIS devices exhibit good thermometric response in the range of temperatures from 0.1 K to slightly *above* T_C. Nonlinearity in the current-voltage characteristics was also observed at temperatures higher than T_C, indicating the possible presence of a pseudogap in these TiN films, similar to our earlier studies with ALD grown TiN [1].

[1] A. Torgovkin, S. Chaudhuri, J. Malm, T. Sajavaara, and I. J. Maasilta,
IEEE Trans. Appl. Supercond. 25, 1101604 (2015).