



Contribution ID: 269

Type: **Contributed**

Controlling the Boron-to-Titanium Ratio in Magnetron-Sputter-Deposited TiB_x Thin Films via Preferential Ionization of Sputter-Ejected Ti

Monday 18 June 2018 11:55 (20 minutes)

TiB_x thin films grown from compound TiB_2 targets by magnetron sputter deposition are typically highly over-stoichiometric, with x ranging from 2.4 to 3.5, due to differences in Ti and B preferential ejections angles and gas-phase scattering during transport between the target and the substrate. We show that the use of highly-magnetically-unbalanced magnetron sputtering of TiB_2 target leads to selective ionization of sputter-ejected Ti atoms which are steered via an external magnetic field to the film, thus establishing control of the B/Ti ratio with the ability to obtain stoichiometric TiB_2 films over a wide range in Ar sputtering pressures.¹

We further demonstrate that stoichiometric TiB_2 films can be obtained using high power impulse magnetron sputtering (HiPIMS) in Ar; the B/Ti ratio x is controllably varied from 2.08 to 1.83 by adjusting the length of HiPIMS pulses τ between 100 and 30 μs , while maintaining average power and pulse frequency constant. Energy- and time-dependent mass spectrometry analyses of ion fluxes incident at the substrate position show that the density of metal ions increases with decreasing τ , due to a dramatic increase in the peak target current density and strong gas rarefaction. With $\tau < 60 \mu\text{s}$, film growth is increasingly controlled by incident ions rather than neutrals. Thus, since sputter-ejected Ti atoms have a higher probability of being ionized than B atoms due to their lower first ionization potential and larger ionization cross-section, the Ti concentration in as-deposited films increases with decreasing τ as ionized sputtered species are steered to the substrate by the plasma in order to maintain charge neutrality.

1 I. Petrov, A. Hall, A.B Mei, N. Nedfors, I. Zhirkov, J. Rosen, A. Reed, B. Howe, G. Greczynski, J. Birch, L. Hultman, J.E. Greene, J Vac Sci Technol A, 35 050601 (2017)

Author: PETROV, Ivan (Department of Physics (IFM), Linköping University, SE-58183 Linköping, Sweden and Frederick Seitz Materials Research Laboratory and Department Materials Science, University of Illinois, Urbana, Illinois 61801, USA)

Co-authors: BAKHIT, Babak (Department of Physics (IFM), Linköping University, SE-58183 Linköping, Sweden); GREENE, J.E. (Thin Film Physics Division, Department of Physics (IFM), Linköping University, SE-58183 Linköping, Sweden and Frederick Seitz Materials Research Laboratory and Department Materials Science, University of Illinois, Urbana, Illinois 61801, USA); HULTMAN, Lars (Department of Physics (IFM), Linköping University, SE-58183 Linköping, Sweden); ROSEN, Johanna (Department of Physics (IFM), Linköping University, SE-58183 Linköping, Sweden); GRECZYNSKI, Grzegorz (Department of Physics (IFM), Linköping University, SE-58183 Linköping, Sweden)

Presenter: PETROV, Ivan (Department of Physics (IFM), Linköping University, SE-58183 Linköping, Sweden and Frederick Seitz Materials Research Laboratory and Department Materials Science, University of Illinois, Urbana, Illinois 61801, USA)

Session Classification: Thin Films & Surface Engineering

