Effect of synchronous bias mode with different duty cycles on microstructure and mechanical properties of AlTiN coatings deposited by HiPIMS process

Jian-Fu Tang[a], Shi-Yu Huang[b], I-Hong Chen[b,†], Guan-Lun Shen[b], Chi-Lung Chang[b,c,*]

[a] Department of Electronic Engineering, Lunghwa University of Science and Technology, Tao-Yuan, Taiwan, R.O.C
[b] Department of Materials Engineering, Ming Chi University of Technology, New Taipei City, Taiwan, R.O.C
[c] Center for Plasma and Thin Film Technologies, Ming Chi University of Technology, New Taipei City, Taiwan, R.O.C

†Presenter
*Corresponding author's e-mail: clchang@mail.mcut.edu.tw

Abstract

In the present work, we evaluated the synthesis of AlTiN coatings through HiPIMS with variable duty cycle (3%, 6%, 12%, 18%) under synchronous pulse-DC (SP-DC) bias and with trigger delay 50 μs bias (TD50). The influence of these processing conditions on the microstructure and mechanical properties of AlTiN was investigated. FE-SEM analysis results showed a highest deposition rate of 22.1 nm/min when TD50 with 3% duty cycle. The results of EPMA and XRD show that when the Al/Ti ratio x is between 0.71 to 0.74, the h-AlN structure will be generated. The results of TEM and nanoindenter analysis show that the DC bias transforms into synchronous bias boosting the bias output time (increasing duty cycle) will refine the AlTiN grains from about 150 to 20 nm, increasing the hardness from 22.7 to 24.7 GPa.Meanwhile, the residual stress of AlTiN thin film increased from 0.2 to -1.51 GPa, and obtain a higher adhesion strength 54.8 N on synchronous bias with 6% duty cycle condition. Therefore, the both duty cycle and trigger delay under synchronous pulse-DC bias also can as an important function of HiPiMS process parameter.

Keywords: synchronous bias, duty cycle, high-power impulse magnetron sputtering, AlTiN coating