Effect of acetylene gas flow rates on target poisoning, phase composition, microstructure, mechanical properties and corrosion resistance of AlCrNbSiTiC high entropy alloy carbide thin films

Hsiang-Yu Tsai[1,2], Yung-Chin Yang[1], Chia-Lin Li[2], Bih-Show Lou[3.4], Jyh-Wei Lee[2,5,6,7*]

[1]Department of Materials and Mineral Resources Engineering, Institute of Materials Science and Engineering, National Taipei University of Technology, Taipei, Taiwan

[2]Center for Plasma and Thin Film Technologies, Ming Chi University of Technology, New Taipei, Taiwan

[3]Chemistry Division, Center for General Education, Chang Gung University, Taoyuan, Taiwan

[4]Department of Orthopaedic Surgery, New Taipei Municipal TuCheng Hospital, Chang Gung Memorial Hospital, Taiwan

[5]Department of Materials Engineering, Ming Chi University of Technology, New Taipei, Taiwan

[6]College of Engineering, Chang Gung University, Taoyuan, Taiwan

[7]High Entropy Materials Center, National Tsing Hua University, Hsinchu, Taiwan

[*]Corresponding author, E-mail: **jefflee@mail.mcut.edu.tw**

High entropy alloy carbide (HEAC) differs from conventional carbides, which are typically composed of one or two metallic elements. HEAC demonstrates remarkable properties, including an extremely high melting point, enhanced hardness, and superior wear resistance. In this study, AlCrNbSiTiCx HEAC thin films with varying carbon contents were deposited using a superimposed high power impulse magnetron sputtering (HiPIMS) and medium-frequency (MF) sputtering technique by a plasma emission monitoring (PEM) feedback control system. The optical emission signal of Cr element was monitored under different argon/acetylene gas flow ratios and the target poisoning effect was studied by the PEM system. The cross-sectional morphology, chemical composiitons, and crystal structure of the films were characterized using field emission scanning electron microscopy (FE-SEM), FE-electron probe microanalyzer (FE-EPMA), and X-ray diffraction (XRD), respectively. The mechanical properties of the HEAC thin films, including hardness, elastic modulus, adhesion, and wear resistance, were evaluated using nanoindentation, scratch testing, and pin-on-disk wear testing. The corrosion resistance of HEAC films in the in 0.5M sulfuric acid aqueous solution was explored. This study systematically investigated the influence of target poisoning ratios and carbon content on the phase composition, microstructure, mechanical properties, and corrosion resistance of AlCrNbSiTiCx HEAC thin films. Potential applications of these HEACS films were also proposed in this work.