

# **Exploring the microstructure and mechanical properties of TiZrNbTaMoN high entropy alloy nitride coating: Effect of nitrogen content**

Sen-You Hou<sup>1</sup>, Po-Yu Chen<sup>1,2</sup>, Bih-Show Lou<sup>3,4\*</sup>, Jyh-Wei Lee<sup>2, 5, 6, 7</sup>

<sup>1</sup>Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan

<sup>2</sup>High Entropy Materials Center, National Tsing Hua University, Hsinchu, Taiwan

<sup>3</sup>Chemistry Division, Center for General Education, Chang Gung University, Taoyuan, Taiwan

<sup>4</sup>Department of Orthopaedic Surgery, New Taipei Municipal TuCheng Hospital, Chang Gung Memorial Hospital, Taiwan

<sup>5</sup>Department of Materials Engineering, Ming Chi University of Technology, New Taipei City, Taiwan

<sup>6</sup>Center for Plasma and Thin Film Technologies, Ming Chi University of Technology, New Taipei, Taiwan

<sup>7</sup>College of Engineering, Chang Gung University, Taoyuan, Taiwan

The high power impulse magnetron sputtering (HiPIMS) generates high density plasma through higher instantaneous pulse currents, resulting in thin films with fewer defects, higher density, and denser microstructure. In this work, a combination of HiPIMS and radio frequency power supply system was used to deposit TiZrNbTaMoN high entropy alloy (HEA) thin films with varying nitrogen contents on Si wafer, AISI304 and 420 stainless steel substrates. The cross-sectional morphology, composition, and crystal structure of thin films were analyzed using scanning electron microscopy, electron probe microanalyzer, X-ray diffraction, and transmission electron microscope, respectively. Subsequently, potentiodynamic polarization corrosion tests were conducted on the HEA thin films in 3.5 wt.% NaCl aqueous solution using an electrochemical workstation to evaluate their corrosion resistance. We found that TiZrNbTaMoN HEA nitride coatings exhibited a hardness of up to 29 GPa, along with outstanding corrosion resistance. The effect of nitrogen content on the phase, mechanical properties, and corrosion resistance of TiZrNbTaMoN HEA thin films was discussed in this work. The potential applications for the TiZrNbTaMoN HEA thin films in the machining industries were proposed.

**Key Words:** high power impulse magnetron sputtering, TiZrNbTaMoN high entropy alloy nitride coating, corrosion resistance, hardness.