Hardness and toughness enhancement of nanotwinned high entropy alloy FeMnNiCoCr coatings deposited by closed field unbalanced magnetron sputtering

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The rationale of high entropy alloys (HEAs) is that the stability of those alloys containing multiple equiatomic or near-equiatomic elements is enhanced by their strikingly high configurational entropies of, typically, cubic phases. The study of FeMnNiCoCr-based HEA's has been documented in regard of their high temperature stability, exceptional fracture toughness and promising mechanical properties. In the present work, a range of FeMnNiCoCr coatings, deposited on AISI M2 steel substrates using a closed field unbalanced magnetron sputtering technique, as a function of applied substrate bias, were investigated. A range of characterization methods were used to investigate their microstructures and mechanical properties, mainly transmission electron microscopy (TEM), and nanoindentation tests. These investigations demonstrated that the FeMnNiCoCr coatings comprised elongated grains that exhibited coarsening under increased substrate bias. TEM and diffraction investigation showed that the fine fcc grains of these coatings contained high densities of {111} nanotwins. It is suggested that these twins contribute to the high hardness (~9 GPa) values of these coatings.