Mechanically Robust Multi-Principle Element Alloy Coatings for Surface Protection

Tsianikas, S.[1], Chen, Y.[1] and Xie, Z.[1]

[1] The University of Adelaide, Australia

<Alloys are used extensively in various fields such as aircraft construction, bioengineering, and chemical processing. Since the mid-2000s, Multi-Principal Element Alloys (MPEAs) have become a field of significant research. These alloys can provide novel and advantageous properties that traditional materials cannot provide, such as high thermal stability, good wear, and oxidation resistance.

In this emerging field of research, very few studies are focusing on using MPEAs for protective coatings. The aim of this research is to explore the mechanical properties and deformation mechanisms of CoCrNi coatings deposited on tool steel via radiofrequency magnetron sputtering. The mechanical properties are measured via nanoindentation, and deformation mechanisms are determined via pre- and post-mortem scanning transmission electron microscopy (STEM) techniques on samples prepared via the focussed ion beam milling lift-out technique. The coatings exhibit a high hardness (values of approximately 10 GPa; significantly higher than that of the bulk material), enabled by a unique, hierarchical microstructure, as revealed by STEM images. In particular, multi-phase nanocolumns of FCC and HCP, and defects such as; stacking faults, twinning, and dislocations are all present. Examination of pre- and post-mortem STEM samples reveals that dislocation motion is a major deformation mechanism of the coatings. The coatings also possess good ductility that challenges conventional wisdom, i.e. the strength-ductility tradeoff. The results of this analysis demonstrate that new CoCrNi coatings with a sophisticated microstructure can provide effective surface protection.>

<This project is funded by the Australian Research Council ARC Grant DP160104632. I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship, administered by The University of Adelaide on behalf of the Department of Education and Training of the Australian Government.>