Strengthening characteristics of multi-phase, multi-principal element alloys probed by indentation methods

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Understanding the origin of strength in a given material system is always important for the researchers / scientists as it gives a clue towards which microstrural feature needs to be modified so that novel materials with enhanced properties can be designed and developed. This is an ever-evolving pursuit. In recent times, multi-principal element alloys (MPEAs) have taken center stage of the materials development branch and in these material systems all the participating elements will have equal representation w. r. t. the composition. These novel MPEAs have exhibited unprecedented mechanical properties although the origin of the strength is not well understood. Our recent efforts include design and development of various MPEAs and their characterization using X-ray diffraction and several microscopy-based techniques. Mechanical properties were evaluated using microindentation and depth-sensing nanoindentation. We always have deduced the reasons for the strength (hardness) in these alloys considering various strengthening mechanisms such as solid solution strengthening, Hall-Petch strengthening, Taylor hardening, twin boundary strengthening, lattice frictional stress etc. This presentation would highlight our considerations for the development of MPEAs and the contributing factors for the hardness/strength observed in this new class of systems.