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Nanomechanical testing of nitrided and nitrogen ion implanted high entropy alloys.

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Over the last decades, nanoindentation has been recognized as a valid technique to investigate the localized mechanical responses at micro or nanoscale. Recently, it has also been supported by compression or tensile tests of micro sized samples. These techniques are perfectly suited for the characterization of the mechanical properties of thin layers modified by interaction with high or medium energy ions. These layers are characterized by inhomogeneous distribution of defects and areas in which phase transformation occurs.
In this research bulk HEAs – AlCoCrFeNiTi0.2 underwent plasma nitriding and ion implantation to investigate changes in microstructure and mechanical properties within the surface layer. X-ray diffraction analysis revealed a transformation from BCC and σ phases to a predominantly FCC crystallographic structure. Further analysis utilizing SEM EDS, EBSD, and DFT numerical simulations uncovered the presence of (Ti, Cr)N, AlN, and NaCl-type (AlCrCoFeNiTi0.2)N high entropy nitrides. Plasma nitriding also induced high surface porosity.
Fortunately, micro-pillar compression testing coupled with in-situ multi-nanoindentation exhibited localized areas of significant hardening. Additionally, a drastic reduction in the coefficient of friction in all the investigated samples was observed. These findings not only offer deeper insights into the nitriding process of complex alloys like HEAs but also hold promise for further exploration in creating super-hard surfaces with High Entropy Nitrides, thereby improving mechanical properties for applications in harsh environments.

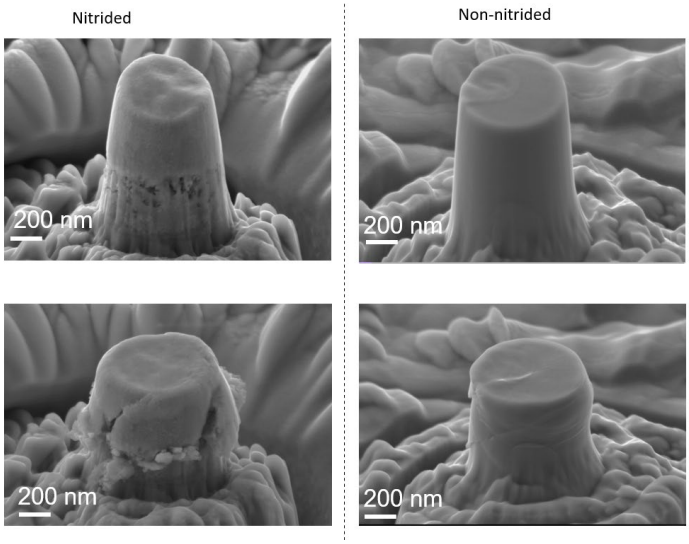

Figure 1 – Nitrided and non-nitrided micorpillars before and after the compression tests.

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