World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:16, No:03, 2022

The Mechanical Properties of In-Situ Consolidated Nanocrystalline Aluminum Alloys

Authors : Khaled M. Youssef, Sara I. Ahmed

Abstract : In this study, artifacts-free bulk nanocrystalline pure aluminum alloy samples were prepared through mechanical milling under ultra-high purity argon and at both liquid nitrogen and room temperatures. The nanostructure evolution during milling was examined using X-ray diffraction and transmission electron microscope techniques. The in-situ consolidated samples after milling exhibited an average grain size of 18 nm. The tensile properties of this novel material are reported in comparison with coarse-grained aluminum alloys. The 0.2% offset yield strength of the nanocrystalline aluminum was found to be 340 MPa. This value is at least one order of magnitude higher than that of the coarse-grained aluminum alloy. In addition to this extraordinarily high strength, the nanocrystalline aluminum showed a significant tensile ductility, with 6% uniform elongation and 11% elongation-to-failure. The transmission electron microscope observations in this study provide evidence of deformation twinning in the plastically deformed nanocrystalline aluminum. These results highlight a change of the deformation mechanism from a typical dislocation slip to twinning deformation induced by partial dislocation activities.

Keywords : nanocrystalline, aluminum, strength, ductility
Conference Title : ICMAMS 2022 : International Conference on Metal Alloys and Materials Science
Conference Location : Miami, United States
Conference Dates : March 11-12, 2022