Development of nano-Y_2O_3 dispersed Zr alloys synthesized by mechanical alloying and consolidated by pulse plasma sintering

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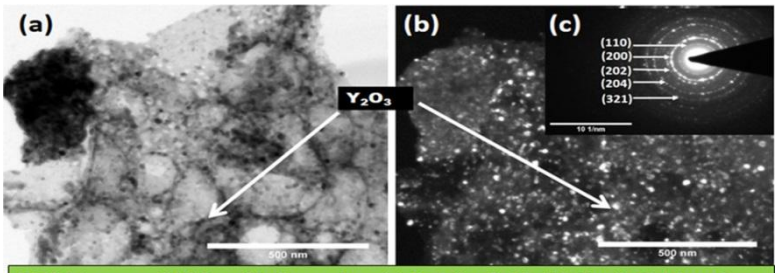
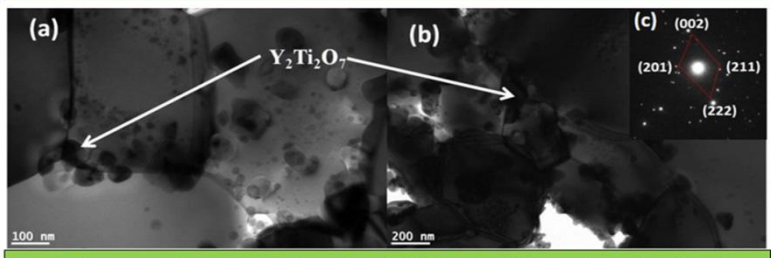
In this paper, Zr alloys are synthesized with nominal compositions: 50Zr-30Fe-10Cr-5Cu-5Ti (alloy A), and 49Zr-30Fe-10Cr-5Cu-5Ti-1Y_2O_3 (alloy B), 45Zr-30Fe-10Cr-10Cu-5Ti (alloy C), 44Zr-30Fe-10Cr-10Cu-5Ti-1Y_2O_3 (alloy D) (all in wt%) by mechanical alloying and consolidated by pulse plasma sintering at 1173 K (900 °C), 1223 K (950 °C) and 1273 K (1000 °C) using 75 MPa uniaxial pressure applied for 5 min and 70 kA pulsed current at 3 Hz pulse frequency. The microstructure and phase evolution during mechanical alloying and sintering has been characterized by X-ray diffraction (XRD), scanning and transmission electron microscopy (SEM & TEM) and energy dispersive spectroscopy (EDS). Mechanical properties i.e. hardness and compressive strength were determined by using nano-indentation unit and universal testing machine. The produced alloys recorded very high levels of compressive strength (1359–2456 MPa), and hardness (7.05–10.05 GPa) which measures 1.5–2.0 times more than that of other Zr alloys (< 1000 MPa) as available in the literature. Those impressive mechanical properties can be attributed to the microstructure of the developed alloys constituted by Zr matrix containing uniform dispersion of nanomertic (10–20 nm) oxide (Y_2O_3) particles which can contribute to grain boundary pinning, and improved creep and oxidation resistance at elevated temperature. **More in Materials Characterization, DOI: 10.1016/j.matchar.2017.12.038**



TEM image of 10 h milled powder (a) Bright field, (b) Dark field and (c) corresponding SAD pattern image of Alloy B.



TEM images of alloy D sintered at 1273K (1000°C): (a) (b) bright field image, and (c) corresponding SAD pattern.