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Microstructural and crystallographic characterization of spark plasma sintered Ti-Zr and Ti-Ta based alloys

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Ti-Ta and Ti-Zr alloys have been identified to possess capabilities to meet the demand for light weight, commercially friendly and functionally viable high temperature shape memory applications in the aerospace industries. Characterization is at the core of understanding the phenomenological relationship between the processing method and the final materials properties. In contrast to the preponderance of reported work on the characterization of shape memory alloys fabricated from conventional techniques, not much work involving the uses of spark plasma sintering is available. In this study, Ti-30Ta and Ti-30Zr based alloys have been fabricated from elemental powders, using spark plasma sintering under varying process parameters including: sintering time, sintering pressure and powder formulations. As sintered powders were characterized for their relative density, and indentation microhardness using Archimedes buoyancy method and Vickers indentation techniques respectively. Metallographically prepared specimens were subjected to microstructural and chemical analyses using Field Emission Scanning Electron Microscope (FE-SEM) equipped with Energy Dispersive X-ray Spectroscopy (EDS) respectively. Crystallographic properties were also determined using X-ray Diffraction (XRD) and Electron Backscattered Diffraction (EBSD). The thermal properties of the sintered alloys were also determined using laser flash analyses and differential scanning calorimetry. The microstructural results showed improved twinned martensite plate formation with increase in the percentage of Zr content as shown in. Furthermore, Ta was found to stabilize beta phase in Ti while the Zr stabilize the alpha phase. Almost full densification was achieved with increase in the Zr content.

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