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Microstructural evolution and mechanical properties of multiwall carbon nanotubes reinforced titanium-based nanocomposites developed by spark plasma sintering

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Abstract

In this study, the role of multiwall carbon nanotubes (MWCNT) on the microstructural evolution and mechanical properties of Ti6Al4V-based composites was investigated. This was conducted by dispersing different concentrations (0.5, 1.0 and 1.5 wt%) of MWCNT into the Ti6Al4V matrix using shift-speed ball milling technique. Thereafter, the Ti6Al4V and the nanocomposites were consolidated via the spark plasma sintering technique. Various characterization techniques; scanning electron microscopy (SEM), transmission electron microscopy (TEM) and light microscopy were conducted to understand the microstructural evolution of the samples after the dispersion and sintering process. Subsequently, micromechanical and nanoindentation was carried out to reveal the mechanical properties of the fabricated samples. The morphological examination using SEM and TEM revealed the dispersibility of MWCNT dispersed within the Ti6Al4V matrix. Besides, the selected area diffraction and the fast Fourier Transform pattern demonstrated that the increase in concentration of the MWCNT exposed the nanotubes to adverse stresses during the dispersion process. Furthermore, the incorporation and increase in concentration of the MWCNT in the titanium alloy resulted in microstructural and phase changes, which translate to tremendous improvements in microhardness, nanohardness and elastic modulus up to 46.9%, 150.8%, and 169.5% respectively.