Raji, S.A., Popoola, A.P.I., Pityana, S.L. *et al.*

Microstructure and Mechanical Properties of Heat-Treated Ti-Al-Si Alloy Produced via Laser In Situ Alloying.

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**ABSTRACT:**

Intermetallics based on gamma titanium aluminide ($\gamma$-TiAl) alloys are potential lightweight materials that can be used for high-temperature components. However, poor room temperature ductility hinders their full potential for producing components using conventional manufacturing routes. This work is focused on the study of the microstructure and mechanical properties of ternary Ti-Al-Si alloy fabricated through laser in situ alloying by utilizing laser engineered net shaping (LENS) technology with subsequent heat treatment. The produced samples were analyzed using a scanning electron microscope (SEM) equipped with an energy-dispersed spectroscope (EDS) to investigate the composition and microstructure. Phase identification was investigated with x-ray diffraction (XRD) and electron backscattered diffraction (EBSD). Vickers hardness testing machine was utilized to determine the microhardness values, while the yield strength and tensile strength were calculated from the hardness results. Based on the results obtained, the microstructure of the heat-treated and as-produced ternary Ti-Al-Si alloy comprised mainly of $\alpha_2$-$Ti_3Al$, $\gamma$-TiAl and $\zeta$-$Ti_5Si_3$ phases. The SEM and EBSD results confirmed the phases formed, especially the fine lath structures of $\alpha_2$ in the colonies of $\alpha_2/\gamma$ lamellae. The quantity of $\zeta$-$Ti_5Si_3$ present in the LENS produced ternary alloy contributed majorly to the reported microhardness values. The sample heat-treated at 1150 °C/15 min/air-cooled (AC)/950 °C /6 h/furnace cooled (FC) (sample E1) had the lowest microhardness value of 624 Hv (6118 MPa or 6.12 GPa), with a corresponding tensile strength of 2325 MPa and yield strength of 1022 MPa. This was ascribed to the occurrence of more colonies of $\alpha_2/\gamma$ lamellar in comparison with other samples.