PHASE EVOLUTION AND HIGH-TEMPERATURE COMPRESSIVE STRENGTH OF Ti-BASED ALLOY DEVELOPED BY MICRO-PLASMA POWDER ADDITIVE MANUFACTURING

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This manuscript explains the development of lightweight and high-temperature strength Ti-based alloy by micro-plasma powder additive manufacturing (micro-PPAM) process for aerospace and automotive industries. Multicomponent Ti45-V45-Al5-Cr5 alloy was designed by thermodynamic parameters and CALPHAD modeling. Scheil solidification showed that the complete solidification of the developed alloy is the BCC_B2 phase. Equilibrium solidification showed that the BCC_B2 phase forms at T ≤ 2000 K, and the HCP_A3 phase forms at T ≤ 900 K, whereas solidus temperature is 1900 K. Optimum values of power for μ-plasma arc formation, travel speed of μ-plasma torch, and mass flow rate of feedstock powder were found for multi-layer depositions of the developed alloy using a combination of maximum deposition efficiency, minimum aspect ratio, and minimum % dilution among the uniform and continuous single-layer deposited of the developed alloy. The optimal parameters for the multi-layer deposition of the developed alloy were power for μ-plasma arc formation is 418 W, travel speed of μ-plasma torch is 51 mm/min, and mass flow rate of feedstock powder is 2.9 g/min. Microstructure, formation of phases, microhardness, and High-temperature compressive strength of multi-layer deposition of the developed alloy were studied. The entire phase of the developed alloy is BCC which shows the V-rich phase and Ti-rich phase, and elemental colour mapping implies that Cr is enriched in V-rich phase and Al is enriched in Ti-rich phase. The uneven distribution is due to differences in melting points of all elements during non-equilibrium solidification of solid solution alloys. XRD graphs of the developed alloy showed that it exhibits the BCC phase, and no other secondary phase peaks were observed. The compressive strength of Ti-based alloy was obtained at 900°C, 1000°C, and 1100°C at a strain rate of 10^{-3} S^{-1}. The developed alloy showed a high compressive strength of 590 MPa at 900°C due to solid solution and constituent element strengthening. The developed alloy is useful for high-temperature, high-strength, and lightweight applications in the automotive and aerospace industries.

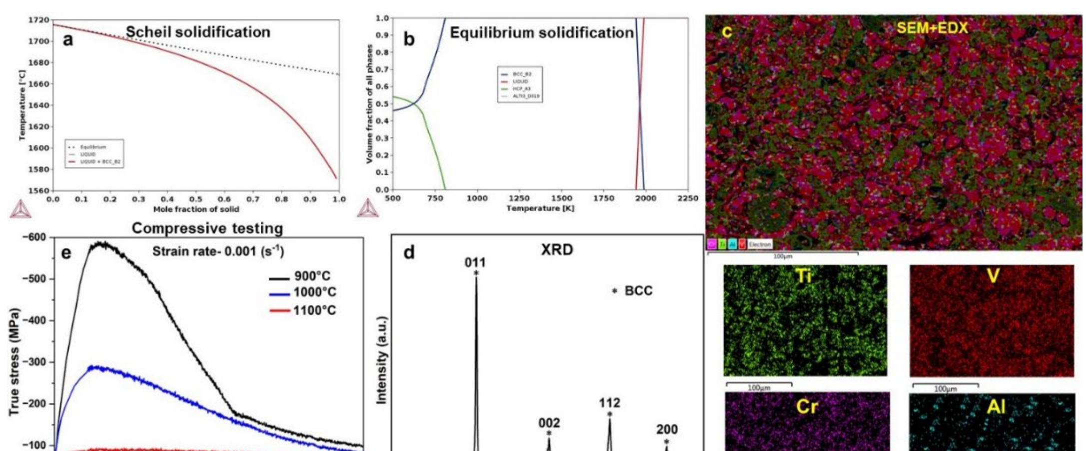

Figure 1 (a) Thermo-calc simulated Scheil solidification, (b) Thermo-calc simulated Equilibrium solidification, (c) Microstructure and its elemental colour mapping, (d) Evolution of phases, and (d) high-temperature compressive strength.