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Thermomechanical processing of a high strength metastable beta titanium alloy powder, consolidated using the low-cost FAST-*forge* process

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Abstract

The high strength titanium alloy Ti-5553 has been fully consolidated and thermomechanically processed from powder using the FAST-*forge* process, in only three steps, both at the small and the pilot scale. Titanium alloy components are conventionally produced using a time-consuming process, which involves carbo-chlorination extraction of TiO_2, triple vacuum arc re-melting, and multiple thermomechanical and heat treatment steps, before machining. The proposed FAST-*forge* processing route for titanium alloy components cuts out or significantly reduces these stages, and uses field-assisted sintering technology (FAST) to consolidate powder. This paper assesses the effectiveness of the process for a conventionally used high-strength beta titanium alloy, Ti-5553. Ti-5553 has been fully consolidated by the FAST process at two different dwell temperatures, 850 and 1000°C, and for a 30 minute dwell time. Small-scale upset forging of cylinders machined from each FAST condition has been performed at forging temperatures 785, 810 and 835°C, and strain rates 0.01, 0.1, 1 and 5 s^{-1}, in order to examine the flow stress behaviour. The flow behaviour of both FAST-produced Ti-5553 specimens was found to be very similar to conventionally produced Ti-5553, and the forged microstructures were also comparable. Large-scale forging