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A Method for the In-Situ Study of Solid-State Joining Techniques using Synchrotron Radiation - Observation of Phase Transformations in Ti-6Al-4V after Friction Surfacing

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Abstract

The solid-state deposition process Friction Surfacing (FS) was applied to Ti-6Al-4V alloy on portable welding equipment at a high-energy synchrotron beamline. The heat input and coating thickness were altered by varying the deposition speed. X-ray diffraction was carried out in-situ during the deposition process and the cooling of the coated samples. Phase transformations were evaluated and correlated with thermal cycles determined by thermocouples and an infrared camera. SEM investigation of the coating microstructure was conducted to examine the morphology of the α phase. During FS the coating material is severely deformed and dynamically recrystallized in the β phase state at temperatures >1300°C. Small changes in the β grain size were observed within the first 2 s after deposition only. Depending on the cooling rate it transforms into different types of α phase during cooling. Phase transformation rates were found to correlate well with the differences in α morphology. The two faster translational speeds showed transformation rates >45 vol%/s and a partially martensitic microstructure.

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