Modelling and Simulation of Metal Deposition on a Ti-6al-4v Plate

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ABSTRACT

There are many challenges in producing aerospace components by metal deposition (MD). One of them is to keep the residual stresses and deformations to a minimum. Another one is to achieve the desired material properties in the final component. A computer model can be of great assistance when trying to reduce the negative effects of the manufacturing process. In this work a finite element model is used to predict the thermo-mechanical response during the MD-process. This work features a physically based plasticity model coupled with a microstructure evolution model for the titanium alloy Ti-6Al-4V. A thermally driven microstructure model is used to derive the evolution of the non-equilibrium compositions of α-phases and β-phase. Addition of material is done by activation of elements. The method is taking large deformations into consideration and adjusts the shape and position of the activated elements. This is particularly important when adding material onto thin and flexible structures. The FE-model can be used to evaluate the effect of different welding sequences. Validation of the model is performed by comparing measured deformations, strains, residual stresses and temperatures with the computed result. The deformations, strains and temperatures are measured during the process. The deformations are measured with a LVDT-gauge at one location. The strains are measured with a strain gauge at the same location as the deformations. The temperature is measured at five locations, close to the weld and with an increasing distance of one millimeter between each thermo couple. The residual stresses in MD component were measured non-destructively using high-energy synchrotron X-ray diffraction on beam line ID15A at the ESRF, Grenoble.