Predicted microstructures in repair technology of Ti-6Al-4V

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Laser cladding is a metal deposition technique often used to repair components [1]. Solidification following melting and partial remelting of pre-existing layers is coupled with heat treatment of the solidified material due to the repeated heating and cooling cycles during building. The effect of the building strategy on the metallurgical characteristics of the material for a decreasing track length (DTL) or a constant track length (CTL) strategy is analysed.Optical Microscopy (OM), Stereo Microscopy (SM), and Scanning Electron Microscopy (SEM) were used in order to study the microstructure. The generation of the microstructure results from the material thermal history.

The updated Lagrangian FE code Lagamine developed by ArGEnCo Department of the University of Liège to model forming processes is applied here on the laser cladding process [2]. The 3D-mesh is refined in the deposit and the top of the substrate in order to accurately model heat fluxes while the bottom of the substrate is meshed as coarse as possible. To generate an optimal mesh, transition refinement elements were used. In this powder injection technique, the continuous addition of material on the substrate is modelled by the element birth technique also called "switch" within Lagamine code.

The predicted thermal field is found close from the measurements of type-K thermocouples introduced inside the substrate. Such results were computed for both building strategies: decreasing track length (DTL) and constant track length (CTL) strategy. The predicted temperature histories confirm that a more uniform temperature history is applied to the deposit by the CTL choice than the DTL one. The presence in DTL case of heterogeneity within the hardness measurements and the phases observed by metallography [1] can be explained by the computed temperature distributions. A detailed analysis linking microstructure and thermal history is provided.

[1] Paydas H., Mertens A., Carrus R., Lecomte-Beckers J., Tchuindjang J.T., Laser cladding as repair, technology for Ti–6Al–4V alloy: Influence of building strategy on microstructure and hardness Materials & Design 85, 2015, 497-510.

[2] Tran H.S., Tchuindjang J.T., Paydas H., Mertens A., Jardin R.T., Duchene L., Carrus R., Lecomte-Beckers J. and Habraken A., 2017, "3D thermal finite element analysis of laser cladding processed Ti-6Al-4V part with microstructural correlations" Mater. Des. 128, 130.