LASER ADDITIVE MANUFACTURING OF NIOBIUM SILICIDE-BASED COMPOSITES

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Niobium silicide-based composites, in the application of gas turbine blades, promise significant efficiency improvements compared to current Ni-based alloys. The higher temperature capability would allow the engine to run at a higher temperature than that of current alloys, increasing engine efficiency. Nb-Si based composites possess a lower density, due to the presence of ceramic phases such as Nb_5Si_3 and/or Nb_3Si. This would reduce the weight of the rotating blades. However, improvements in certain properties, such as ductility, room temperature toughness and oxidation resistance are needed. The alloy must also be cost effective to manufacture if niobium silicide systems are to reach their full potential.

This study focuses on the manufacturability aspect of the powder feeding laser additive manufacturing (LAM) process to engineering Nb-Si based alloy samples. A schematic drawing of LAM system is shown in Figure 1. In LAM process, CAD models of the components are constructed and sliced layer by layer for laser multilayer cladding, which directly forms the component shapes. LAM has the advantage of forming near-net shapes without the use of expensive cores and moulds for the reactive Nb-Si melt. Fine microstructure and even chemical composition distribution with reduced macro-segregation are obtained. With the use of power feeding system, new Nb-Si based alloys are LAMed with varying Ti, Si, Cr, Al, Hf, V concentrations. Microstructures and mechanical properties of the LAMed new alloys will be presented, the relationship between mechanical property, alloy chemistry and process variable will be analyzed and the challenges in powder feeding laser additive manufacturing of Nb-Si based composites will be reported.

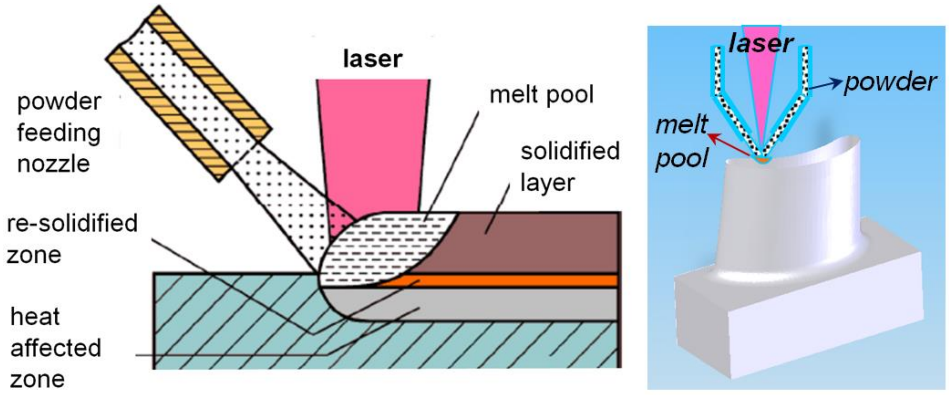

Figure 1 – Schematic diagram of power feeding laser additive manufacturing process

References:

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