Development of an austenitic/martensitic gradient steel by additive manufacturing

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In many applications, additive manufacturing techniques are rising to build, layer-by-layer, component with complex shapes and specific microstructures. With the Direct Metal Deposit (DMD) process, a nozzle delivers the powder directly to the molten pool, generated beneath the laser beam. An advantage of this process is the possibility to tune the material's composition, using different powder feeder, through the powder flow. Thus, it became possible to build composition gradient parts. Gradient components are studied for industrial applications such as functional materials ([1], [2]) or as a way to solve welding problems([3], [4]). In this study, we focused on a gradient from a 316L austenitic stainless steel to a 9Cr-1Mo martensitic steel. These steels are widely used for nuclear applications, and especially for fuel assemblies in Sodium Fast Reactors. Due to their chemical composition differences, welding them is uneasy, requiring filling metal and post-welding heat treatments [5].

The aim of this study is to compare microstructures obtained by traditional Tungsten Inert Gas with graded parts obtained by powder metallurgy, after Spark Plasma Sintering or additive manufacturing with Direct Metal Deposit process.
Microstructures are analyzed using Scanning Electron Microscope (SEM) and Electron BackScatter diffraction (EBSD) and correlated to thermokinetic calculations. The relationships between the mechanical behavior, the microstructures and the processes are discussed.

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