Reconditioning of HPT blade tips

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Abstract

High pressure turbine blades are exposed to high thermal, corrosive and mechanical load. Todays HPT blades consist of superalloys, commonly nickel base. In order to increase the resistance against oxidation attack, the blades have a corrosion coating and an optional thermal barrier coating. Moreover, cooling holes realize a film cooling for further protection. However, after flight operation the blades don't have the length as a new part. Due to the wear between shroud and the blade the blades got shorter and a welding buildup is mandatory in a repair shop visit.

In order to rebuild the blade tips near net shape an automated laser cladding process can be used. Laser cladding is an overlay welding process in order to build up wall like structures or volumetric bodies. The energy for welding the filler material is delivered by a laser beam. The filler material (commonly consisting of powder) is delivered by a coaxial nozzle. The coaxial nozzle realizes the same quality independent of motion direction. Due to the usage of a laser beam the heat can be introduced highly spatial resolved. Hence, a welding process with comparably low heat input is possible. That allows low thermal distortion combined with highly net shaped structures and a high overall process efficiency.

The requirement to repair welding is an adaptive process that reacts on the individual blade distortion coming out of the flight operation. Therefore, in production every blade is individually measured in the laser cell. Afterwards the program is rotatory and translative matched. This allows an individual automated treatment of every blade.

The materials of turbine blades have been further developed towards higher creep resistance. The first blades consisted of polycrystalline material. Afterwards, directionally solidified (DS) materials have been developed. Most of todays high pressure turbine blades consist of single crystal (SX) super alloys. The requirement of welding DS and SX materials make the welding process more difficult. Time temperature regimes and spatial motion control have to be more precise in order to match an even smaller process window. By controlling the laser system it could even be possible to generate SX epitaxial solidification. Hence, the solidifying material has the same crystallographic orientation as the base material.