High Power Fiber Laser Welding of Aerospace Alloys with and without the Filler Material

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Continuous advances in the aircraft and aerospace technology impose ever-increasing demands on the materials used in the components and structures and also impose ever increasing demands upon the engineers to develop new joining techniques.

Titanium and high temperature nickel and cobalt superalloys are used to manufacture and repair in-service damaged hot section components of aeroengines. These materials have excellent high temperature properties, however most of these alloys have poor weldability and suffer from porosity, weld zone and heat affected zone cracking.

Many methods can be used to weld these aerospace alloys. Tungsten Inert Gas (TIG) and Electron Beam (EB) are the most widespread techniques for welding these alloys. However, fiber lasers with its high beam quality and high average power can be a convenient alternative for welding even complex shaped components made of these alloys. The major drawback of the laser welding process is the stringent joint requirements. In the case of a typical butt joint the widest acceptable air gap for autogenous laser welding is usually 10% of the material thickness. These tolerances can be fulfilled when components are relatively small and manufactured with machining or laser cutting. Even in these cases for large components it is difficult to achieve the required accuracy when positioning them. The geometry of a joint, air gap and part mismatch varies from joint to joint and between products and production batches. Filler wire can be used to achieve to compensate for the poor fit-up and mismatch for butt joint welding, control weld geometry and achieve desired weld metallurgy.

Work has been carried at Prima Power Laserdyne to develop laser and processing parameters to produce welds with nickel and titanium-based aerospace alloys to produce good quality welds that meet the stringent requirements of the aerospace industry.