Abdul Kalam Technology Innovation National Fellowship

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Executive Summary

Dr. G. Padmanabham
Director
International Advanced Research Centre for
Powder Metallurgy & New Materials (ARCI)
Hyderabad

1. Title of the Project:

Refurbishment of aero engine components using laser assisted additive manufacturing processes

2. Date of Start of the Project: 1st February, 2019

3. Aims and Objectives:

i. Development of repair technology using laser assisted additive manufacturing for reclamation of expensive aerospace components affected by manufacturing defects and foreign object damage
ii. Development of AM grade powders of new compositions for aerospace repair application
iii. Technology transfer to laser industry

4. Significant achievements

Repair and refurbishment of used and unused components have been widely discussed. HAL, Koraput is one of the biggest Jet engine manufacturers in India. They use a variety of Russian grade alloys and components. A basket of components were identified which require repair solutions as no repair technology is provided by OEM.

In one category, repair solutions are required for conventionally non-weldable alloys such as ZC6Y-BE and BZL-12Y. In second category, repair of HPNGVs are planned that one of most critical and expensive component to repair where the material was found reparable using DED process and HAL is going to supply required ingots and plates to study it further to develop the repair technology.

In order to develop repair solution for ZC6Y-BE and BZL-12Y superalloy, powders were indigenously produced from the cast components using Inert Gas Atomizer available at ARCI-Hyderabad for laser deposition studies.

A systematic laser cladding experimental study is being carried out to evaluate the suitability of indigenously developed powders and to obtain suitable processing parameters and conditions to achieve crack free clads. A detailed microstructural analysis was carried out on the laser cladded samples. The cracking phenomena such as solidification cracking in clad region and liquation cracking in HAZ region is being studied. Solidification and liquation cracking can be controlled by carefully modulating the cooling rates by varying process parameters. Hence, experiments were conducted by preheating the substrate during the build to reduce the cooling rates. Preheating did not show significant influence on solidification cracking. In order to address solidification and HAZ liquation cracking following steps are taken.

- In order to minimize the solidification cracking multi-layers builds were created by building IN718 and base alloy in alternative layers. The results showed promising outcome which are being analyzed to calculate compositional changes required in powder to eliminate solidification cracking.
- In order to minimize the liquation cracking solution heat treatment was done on the as cast substrate prior to the build. The results could minimize the liquation site. A detailed analysis is being carried out.

5. Concluding remarks

ZC6Y-BE and BZL-12Y superalloys are found to be extremely difficult alloys to repair. However, a systematic approach has been taken to understand the cracking phenomena and to eliminate solidification and HAZ liquation cracking.