

L.8 : Study of various compositions of SS-Ni and Ti-Ni for functionally graded joint

Dissimilar metal joint of Ti and SS 304L finds many applications in nuclear and accelerator technology. Premature failure of joints prepared by conventional joining method can be addressed by developing the functionally graded material (FGM). Studies regarding the various transit compositions of Ti and SS 304L with Ni interlayer using Laser Rapid Manufacturing (LRM) were carried out by Laser Materials Processing Division and Accelerator Control and Beam Diagnostic Division at RRCAT.

LRM with fiber laser having 1.2 kW power is used to irradiate the pre-mixed powder layers (of 0.5 mm thickness) of defined compositions to prepare samples for study and analysis of transit compositions. The optical microscopy of various transit compositions of Ti-Ni (Fig. L.8.1(a) to L.8.1(d)) shows that microstructure gradually changes from dendritic to cellular structure with increase in Ni (% wt)

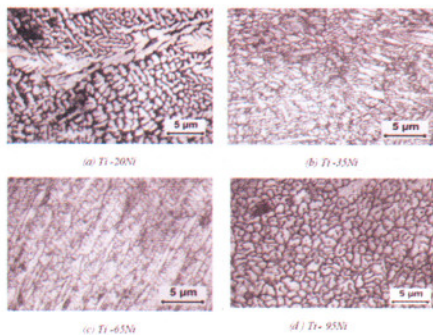


Fig. L.8.1(a) to L.8.1(d): Optical micrographs of various compositions of Ti-Ni deposits

SS-Ni mixture (Fig. L.8.2(a) to L.8.2(d)) shows mixed type of microstructure.

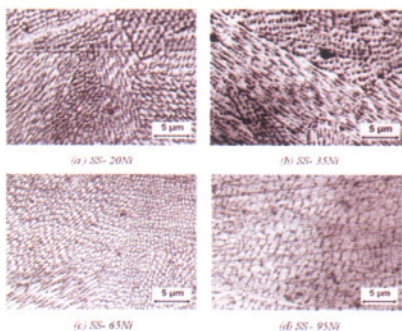


Fig. L.8.2(a) to L.8.2(d): Optical micrographs of various compositions of SS-Ni deposits

The observation of scanning electron microscopy (carried out at XOS, ISUD) of SS-Ni mixture sample (Fig. L.8.3 (a) to L.8.3(d)) shows that cracks exists at higher Ni composition.

However, for Ti-Ni mixture, cracks were observed (Fig. L.8.4(a) to L.8.4(d)) at intermediate percentage of Ni.

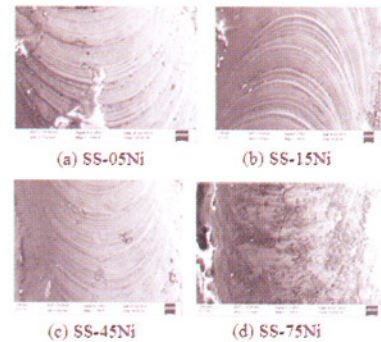


Fig. L.8.3(a) to L.8.3(d): Scanning electron micrograph of various compositions of SS-Ni deposits

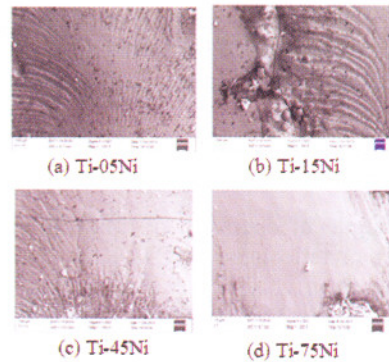


Fig. L.8.4(a) to L.8.4(d): Scanning electron micrographs of various compositions of Ti-Ni deposits

X-ray diffraction analysis (carried out at LMDDDD) of various compositions of Ti-Ni and SS-Ni have revealed the presence of metallic phases of Ti, Ni, and Ti-Ni below the composition Ti-25Ni. Peak corresponding to Ti₂Ni was observed at composition Ti-25Ni. The intensity of the peak increases at the composition Ti-50Ni and afterwards diminishes for the higher compositions. It also shows the presence of Fe, Ni, FeNi and FeNi₃ phases in almost every composition.

Based on the above studies, it is concluded that the interlayers of following compositions of SS-Ni and Ti-Ni mixture should be used for sound functionally graded joint.

- SS-00Ni, SS-20Ni, SS-45Ni, SS-60Ni, SS-80Ni, and SS-100Ni.
- Ti-00Ni, Ti-20Ni, Ti-30Ni, Ti-60Ni, Ti-90Ni, and Ti-100Ni.

Reported by:
Jitendra Singh (jitendra@rrcat.gov.in)
and Dr. C. P. Paul