A.9: Titanium-SS316L transition piece for helium vessel of niobium SRF cavity

Titanium to SS316L bi-metallic transition piece has been developed which can be welded with titanium helium vessel of niobium SRF cavity at one end and two phase stainless steel (SS) pipe at the other end. Being a fully in-house development, this achievement eliminates the compulsion of importing explosion bonded joints and associated technical uncertainties in welding of the explosion bonded transition joint with fusion welding at both the ends. This in-house development is not only a boost to "Make in India" campaign but also brings substantial savings in cost.

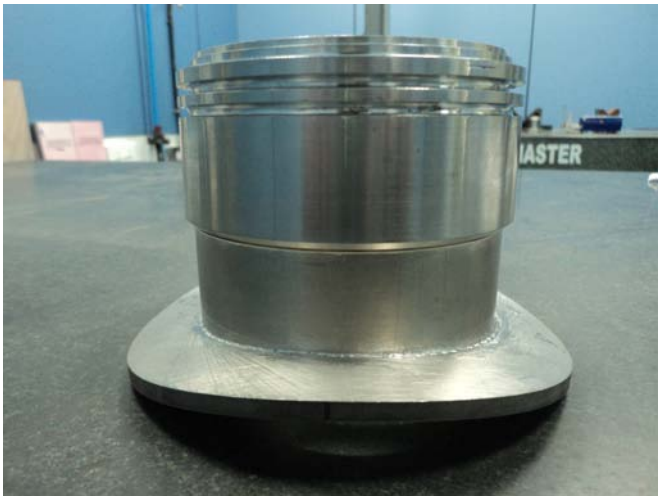

Fig. A.9.1: Ti - SS316L transition piece.

The design has handled the threat of un-joining of imported explosion bonded joints during fusion welding at both the ends by improved design for manufacturing (DFM). A titanium segment having curvature of helium vessel has been welded with the titanium pipe before brazing the titanium pipe with SS pipe. This ensures a safe distance of the brazed joint with the final gas tungsten arc (GTA) weld between the titanium helium vessel and the bimetallic transition joint. On the SS side, two fins have been provided on SS pipe's other surface near the weld location for heat dissipation during its GTA weld with 6 inch nominal pipe size (NPS) SS pipe. The features are flexible in nature and customizable with reference to assembly and functional needs. Vacuum brazing of the assembly has been done using silver copper eutectic alloy. Low strength of the bi-metallic joint has been compensated by deploying a combination of threaded and brazed connection.

A photograph of the transition piece is shown in Figure A.9.1 before its GTA welding with 6 inch NPS two phase pipe made of SS316L. The piece has shown no leak up to a helium background of 6×10^{-10} mbar.l/s. The transition piece has withstood ten thermal cycles between room temperature and liquid nitrogen temperature and one degassing cycle at 350 °C for four hours without any degradation in its helium leak tightness.

Fig. A.9.2: GTAW of transition piece with 2 phase pipe.

Figure A.9.2 shows the transition piece during its welding with the two phase pipe. The brazed joint experienced maximum temperature of 70 °C due to deployment of fins and use of wet cloth jacketing during GTA welding.

Fig. A.9.3: Leak testing of transition piece.

The work has been done in a collaborative manner. Welding of titanium shell portion to titanium pipe was developed at SCDD using EB welding. forming, machining, metrology, plating, heat treatment, vacuum brazing and GTA welding were done at DMTD. LMPD participated in destructive examination of joints during the development phase. UHVTS performed the leak testing at room temperature and liquid nitrogen temperature. Figure A.9.3 shows the leak testing of the piece.

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