I.2: Development of electrical feedthroughs

Non-magnetic, ultra-high vacuum (UHV) compatible and special purpose electrical feedthroughs are required for transmission of electric current into or out of a vacuum chamber. Three different types of feedthroughs have been developed to serve specific purposes:

1. Electrical feedthrough with alumina as insulator: The developed feedthrough has molybdenum conductor, alumina insulator and SS316L CF flange for mounting. Niobium has been chosen as the interface metal with alumina due to its proximity of its expansion coefficient with that of alumina, non-magnetic nature, low Young's modulus and low yield strength. Use of active braze filler metal with niobium interface metal has successfully eliminated the need of metallized ceramic. The brazing process has been done under high vacuum environment, copper silver active braze alloy (CuSIL-ABA) has been used as braze filler metal (BFM) between alumina and niobium as well as between niobium and molybdenum. Copper-silver eutectic has been used as BFM between nickel coated SS316L and niobium. The design incorporates flexible geometrical features to accommodate the stress due to large differential thermal expansion of niobium and SS316L, as shown in Figure I.2.1. The feedthrough has been successfully qualified for its electrical connectivity and ultra-high vacuum performance

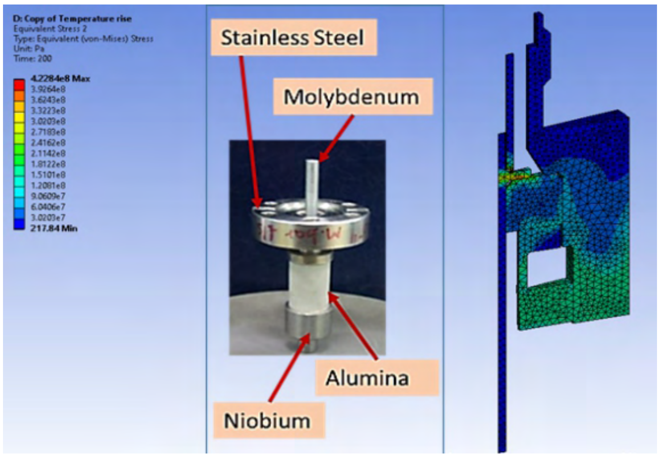

Fig. I.2.1: Electrical feedthrough with alumina as insulator (FEA for compliance feature optimization)

2. Sub miniature version A (SMA) feedthrough with alumina as insulator: A prototype SMA feedthrough for 50 Ω coaxial structures, incorporating two numbers of ceramic to metal joints, has been developed using the aforementioned design philosophy as shown in Figure I.2.2. Compliance feature for stress free joining, single brazing cycle with precisely calculated amount of active precious braze filler metal to avoid short-circuiting are the key highlights of the development. Electrical continuity test has been carried out and it does not show any short path in its coaxial structure. To verify its UHV compatibility, SMA feedthrough was baked up to 150°C for 48 hours (five thermal cycles), and then cooled down to the room temperature followed by helium leak testing. No leak was detected up to a helium background of 1.2×10^{-10} mbar.l/s. The residual gas analyser (RGA) spectrum was also found satisfactory.

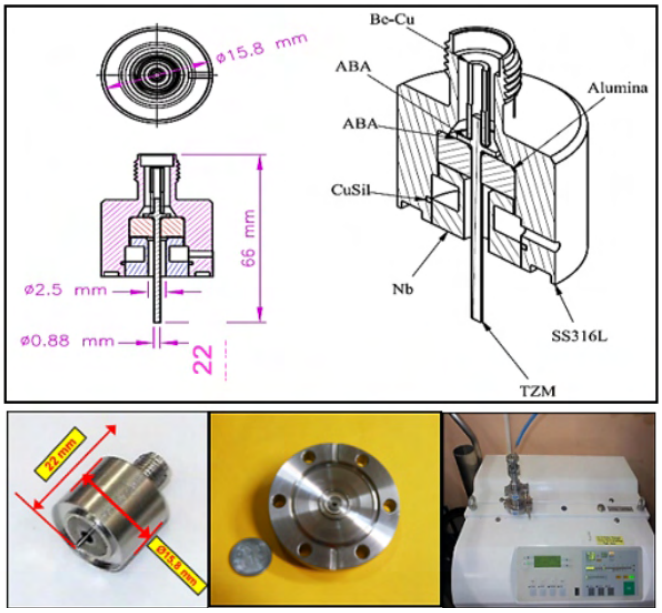

Fig. I.2.2: SMA feedthrough with alumina as insulator.

3. Electrical feedthrough with modified polytetrafluroethylene (PTFE) as insulator: A hermetically sealed modified PTFE insulator-based vacuum feedthrough has also been developed as shown in Figure I.2.3. The feedthrough has three main components namely: nickel-coated copper conductor, SS316L flange, and modified PTFE insulator. Push fit creep resistant joints have been deployed for assembling the components. The design offers low cost and customizable solution that is also suitable for swift production cycles. No leak was detected up to a helium background of 1.2×10^{-10} mbar.l/s.

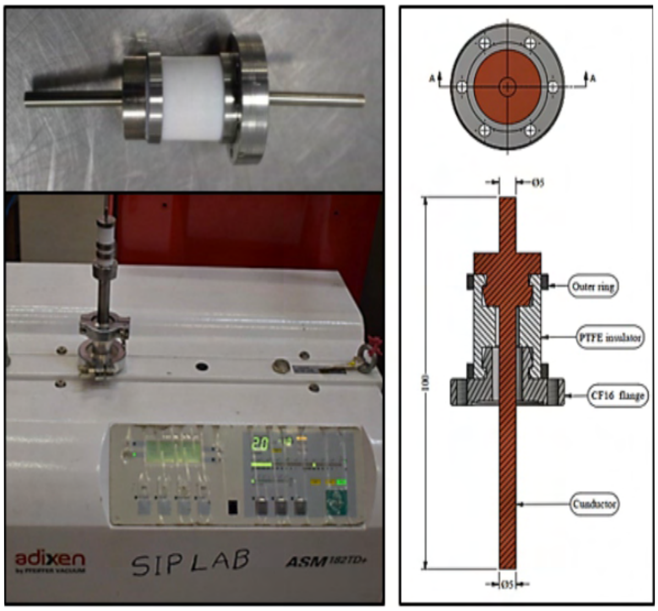

Fig. I.2.3: Feedthrough with modified PTFE as insulator.

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