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DIFFUSION BONDING BY MEANS OF HIP FOR BEAM INTERCEPTING DEVICES AT CERN

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Beam intercepting devices are typically designed to absorb significant thermal power deposited by the particle beam. In many instances, due to various considerations, the heat deposited within a component is dissipated by cooling another material that is in direct contact with the initial part. The effectiveness of this cooling relies on minimising the thermal resistance at the interface.
It has been observed that diffusion bonding minimises (and in some cases eliminates) the thermal resistance at the interface and additionally establishes a clean (ultra-high vacuum compatible) and mechanically robust junction between two components. This ensures reliable and efficient operation over time, even under demanding environment typically found in beam particle accelerators (such as UHV, radiation, thermal/mechanical fatigue, etc).
In the last years, CERN has studied, tested and implemented diffusion bonding techniques by means of Hot Isostatic Pressing (HIP) on operational devices.
The materials employed at CERN and bonded using this technique can be categorised in two groups: i) Cuprous materials combined with stainless steel and ii) refractory metals (such as tungsten, Mo-alloys, Ta-alloys and Nb-alloys). Different combinations of materials within each group have been studied.
For the first group, diffusion bonding is achieved by subjecting the components to HIP at a temperature of approximately 950℃ and a pressure of 100 MPa. Conversely, for the second group, temperatures in the range of 1200-1400℃ and a pressure of 200 MPa are necessary to join the different materials.
Specifically, components made of CuCr1Zr with embedded 316L tubes have been produced and employed as heat sinks in the Proton Synchrotron and Super Proton Synchrotron beam dumps. These systems have been operational since 2021.
This contribution presents the development tests and studies conducted at CERN concerning the application of this technique to these two groups of materials. This encompasses the production of multiple prototype components using different HIP parameters, non-destructive examinations, microstructure inspections as well as thermal/mechanical testing of the interfaces of bonded interfaces.

Themes for the contribution

1 R&D to support concepts

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