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Preparation of Zr-4 Alloy Coated W target plates by HIP Diffusion Welding

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Due to its high density, high melting point, and high thermal conductivity, W is used as a solid target material for scattering neutron sources. However, because of the poor corrosion resistance of W, it is necessary to coating a good corrosion-resistant layer to ensure the long-term use of the target material, Ta metal is a good choice and both have good applications in ISIS and CSNS.
CSNS has initiated the power upgrade project, and by the end of 2029, the power of CSNS will reach 500kW. Under high power conditions, decay heat removal of the target under abnormal beam stop conditions will be a challenge, reducing the decay heat of the target is one way. The calculation results show that the decay heat of zirconium alloy is only one tenth of that of Ta, using zirconium alloy replaced Ta as the target coating material can effectively reduce the decay heat of the target.
Zr- 4 alloy is widely used as a cladding material for nuclear reactors due to its low neutron absorption rate, excellent high-temperature performance, and corrosion resistance. In this study, Zr-4 alloy diffusion welding on the surface of W plate was carried out using hot isostatic pressure (HIP) method. The microscopic analysis of the interface shows that after HIP diffusion welding, a clear diffusion layer is formed at the interface of W and Zr-4 alloy, the selected area electron diffraction pattern analysis results show that the intermediate diffusion layer is ZrW2 phase and the nanoindentation hardness test results show that the hardness of the ZrW2 intermediate layer is significantly higher than that of W and Zr-4 alloy matrix. Meanwhile, as the HIP temperature increases, the thickness of the intermediate layer significantly increases from 0.2μm at 930 ℃ to 11.2 μm at 1400 ℃.

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