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Shape memory alloys for remote connection of beam pipes in radioactive areas

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The ultrahigh-vacuum (UHV) coupling performance of shape memory alloy (SMA) rings was investigated by finite element (FE) simulations and experimental measurements. In particular, the tightening performance of SMA rings, in terms of contact pressure and clamping/unclamping mechanisms, was studied for different values of the initial clearance between ring and vacuum pipe by means of strain gauge (SG) and digital image correlation (DIC) tests. The results have revealed that the contact pressure is not significantly affected by the assembly clearance due to the plateau in the stress-strain response of the material and the thermal dismounting and subsequent re-clamping is obtained by exploiting the two-way shape memory recovery capabilities of the alloy. A design method was proposed that involves the numerical results and a vacuum sealing model. The leak rate measurements, carried out to assess the sealing performance of the couplings, revealed that the constraints for UHV applications could be easily satisfied (leak rate < 10-10 mbar l s-1), which opens the possibility of remotely clamping/unclamping the tight couplers by well-defined changes in their temperature. SMA connectors could be used in high-energy particle accelerators, especially in radioactive areas, where thermally induced mounting and dismounting operations can be activated remotely.

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