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Shape memory alloy technologies for ultra-high vacuum coupling in particle accelerators

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A new generation of ultra-high vacuum (UHV) coupling systems for particle accelerators are currently under investigation at CERN [1,2]. In such systems, the unique thermal recovery features of shape memory alloys (SMAs) are exploited. In particular, thanks to the large strain and stress recovery capabilities of SMAs, ring shaped couplers, to be used as beam-pipe connectors, are being investigated. The use of such technology in restricted access areas, such as the radioactive ones, could result in noticeable advantages, especially during maintenance operations. In fact, SMA couplers can be activated remotely by temperature changes, resulting in significant reduction of the radiation doses collected by the technical personnel.
To this aim, suitable alloy compositions have been selected and special thermo-mechanical training processes have been designed, to satisfy the strict functional constraints in particle accelerators. Both ternary (NiTiNb) and binary (NiTi) alloy systems have been analyzed and their main application limits/advantages have been outlined. Results have shown that leak rate constraints for UHV applications could be easily satisfied (leak rate <10−10 mbar l s−1). Furthermore, thermal mounting/dismounting has been always obtained which allows remote activation and control. Finally, the effects of ionizing radiation on both mechanical and functional responses of SMA couplers are under investigation, by using special facilities at CERN. Preliminary results have shown that leak tightness and thermal dismounting are unaffected by irradiation (up to ˜140 kGy).
Thanks to these features, possible applications in the CERN accelerator complex are considered.

References
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