Understanding the interaction of galling and corrosion in hard facing materials

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Hardfacing alloys have been used for many years in applications that require wear and galling resistance, particularly in extreme environments. Historically, cobalt-based alloys such as Stellite-6 have been used for this purpose on valve sealings in nuclear power plants due to their outstanding tribological and environmental resistance. However, wear and corrosion products from these alloys are carried by cooling water towards the reactor core and irradiated resulting in the formation of gamma-emitter Co-60. This poses an occupational hazard for workers during refuelling thus Co-free replacements are sought.

Novel Co-free hard facing alloys are being developed with empirical success in an effort to reduce worker radiation exposure. These materials must be able to withstand the primary water reactor (PWR) environment i.e. at 300 ◦C in pressurised water for the whole service life of the plant (around 40 years). These alloy matrices have been evolved from stainless steels and enhanced with strengthening precipitates to imitate cobalt alloy microstructures.

However, the fundamentals of galling particularly in pressurised water environment at elevated temperatures are little understood and consequently hard facing alloy design is lacking behind. To date, development alloys have been mainly tested at room temperature and in air, a very different environment to a PWR.

This project aims are to develop experimental protocols of a new set up at the University of Manchester that will, for the very first time, enable galling testing within a pressurised water environment simulating PWR conditions. Building on these protocols, the project will investigate the influence of alloy composition and metallurgical processing methods on wear and galling resistance and test new and existing hardfacing alloys in order to provide improved mechanistic understanding of galling in service relevant conditions. The findings will inform the design of new Fe-based Co-free hardfacing alloy.