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Micro- and nano-scale tribo-corrosion of cast CoCrMo

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The wear damage seen on retrieved CoCrMo hip joint surfaces have been reported to be caused by entrained hard particles in vivo. Such wear damage normally takes place at the micro and/or nano-scale with contact with corrosive body fluids. This study covers the mapping of microabrasion wear mechanisms of cast CoCrMo under various wear-corrosion conditions employing two abrasives, SiC (~ 4 μm) and Al₂O₃ (~ 1 μm), in two test solutions, 0.9% NaCl and 25% bovine serum. Investigation of the micro- / nano-scale wear mechanisms (effect of single abrasive particle) that may be involved during the abrasion process have also been carried out using nanoindentation and nano-scratch techniques. This work shows the abrasive wear rate and wear mechanisms of the CoCrMo are dependent on the nature of the third body abrasives, their entrainment into the contact and the presence of the proteins. The potential detrimental effects of third body hard particles in vivo such as increased wear rates (debris generation) and corrosion (metal-ion release) have been addressed. Surface/sub-surface characterization deploying SEM and FIB-SEM showed that the present test conditions are capable of replicating micro/nano-scale surface / sub-surface micro-structural change that have been seen on retrieved MoM implants. A greater understanding has been established of the material multi-scale wear mechanism as well as for the evolution of the sub-surface nanocrystalline structures and tribolayers.