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M G Bryant

University of Leeds, UK

Exploring the degradation mechanisms and preclinical testing of modular tapers - Past, Present and Future

With more people living longer healthier lives, the demand for high performance joint replacements is continuously growing as are the demands on the performance of the artificial joints to operate for longer periods. Whilst revision due to corrosion-related failure seems to increase, there is a need to understand the metal-biological interfaces from a clinical and pre-clinical perspective. The degradation mechanisms of metallic orthopaedic joints are a complex mixture of mechanical and electrochemical reactions, better known as tribocorrosion. Degradation through wear and corrosion results in changes in local environments eliciting soft tissue reactions often requiring intervention. This will also have a direct impact on the performance of the devices not only from a wear but also electrochemical aspect. Not only do interfacial degradation mechanisms need to be considered from a surface integrity point of view, their specific roles and influence on the degradation products generated and their systematic effects need to be understood. Modular taper interfaces present a current and timely issue in total joint replacements. Whilst work has been active in this area over the past few decades, many of the methods used to assess these interfaces remain basic and the effects of taper variables on the complex degradation mechanisms remain unknown. This is despite the tribocorrosion processes, or fretting-corrosion in this case, established at this interface has been implicated in high revision rates due to metal related biological responses. Comparison of in-vitro modular taper test methods with *in-vivo* retrievals present fascinating differences that presently have not been recreated in laboratory conditions. This paper will present the current understanding around the degradation mechanisms occurring at the modular taper interface. Furthermore the need for future physiologically representative test methods for assessing operational envelopes of new devices and the time dependant degradation processes will be discussed.

Recent Publications:

1. S Kurtz, K Ong, E Lau, F Mowat and M Halpern (2007) Projections of Primary and Revision Hip and Knee Arthroplasty in the United States from 2005 to 2030. The Journal of Bone & Joint Surgery. 89 (4): 780-785.
2. M Morlock, D Bunte, J Guhrs and N Bishop (2017) Corrosion of the Head-Stem Taper Junction-Are We on the Verge of an Epidemic? HSS J. 13 (1): 42-49.
3. H S Hothi, A K Matthies, R Berber, R K Whittaker, J A Skinner and A J Hart (2014) The Reliability of a Scoring System for Corrosion and Fretting, and Its Relationship to Material Loss of Tapered, Modular Junctions of Retrieved Hip Implants. The Journal of Arthroplasty. 29 (6): 1313-1317.

Biography

Notes:

M G Bryant is currently developing research and teaching activities devoted to modern aspects of corrosion, tribology and surface science. This includes surface chemical effects in energy production, bio-tribology, bio-corrosion and methods of mitigation. His research is concerned with understanding and optimising the interactions occurring at interfaces commonly found in many applications. His research addresses a wide range of applications including aerospace, automotive, orthopaedic, cardiovascular and incontinence technologies.

M.G.Bryant@leeds.ac.uk