WEAR PERFORMANCE AND MECHANICAL CHARACTERIZATION OF NEWLY DESIGNED UHMWPE/HYDROGEL COMPOSITES FOR APPLICATION IN ARTIFICIAL JOINTS

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ABSTRACT
Since life expectancy of people is increasing and more artificial joint (AJ) implants are required for people at an earlier age, it is important to improve the life-span of these AJs. Ultra high molecular weight polyethylene (UHMWPE) is the most commonly used material for AJs and the life-span of UHMWPE made implants largely depends on the wear performance, which is extensively related to their mechanical and physical properties, such as hardness, surface finish [1]. This work is to design new composite structures to further improve the wear performance and achieve a longer life-span by improving the load distribution and incorporating a self-lubricating function.

The proposed new structure has three layers – GUR 1020 UHMWPE as a top layer, a middle layer of a high molecular weight poly(vinyl alcohol) (HMW-PVA) hydrogel, and UHMWPE as the bottom layer. This design utilises the excellent mechanical properties of the UHMWPE on the top surface where wear takes place whilst an improvement on the lubricating is expected because of the biphasic characteristic of the hydrogel and its high water content [2].

In addition to this new structure, a surface texturing approach is considered. On the top layer, holes were made with specific diameters (1.0 and 1.5 mm) and distribution (20% surface density), and the middle layer, made of the hydrogel, was connected to the top surface through the holes for improving lubrication and shear stress. The ultimate tensile stress and Young's modulus of the hydrogel were tested, and they are 3.03 MPa and 2.49 MPa, respectively. The obtained mechanical properties of the hydrogel are similar to the one of human cartilage [3, 4], suggesting that the hydrogel can supply the minimum mechanical properties required in AJs. Wear tests were performed on the composites and their wear performance was compared to that of neat UHMWPE samples. A significant improvement on the wear performance was observed with a reduction in the wear rate and friction coefficient of 70% and 48% respectively (Figure 1).

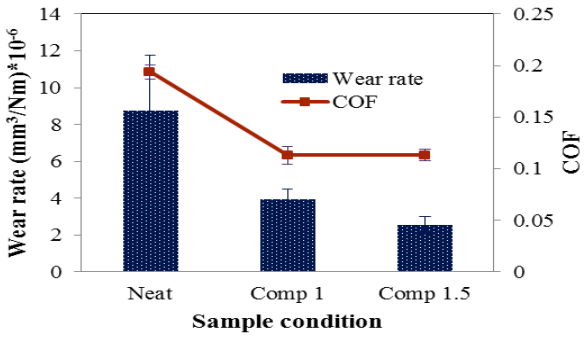

Fig. 1 Wear rate and COF of the Neat UHMWPE and the UHMWPE/HYDROGEL Composites with two different diameter holes (1.0 and 1.5 mm) and 20% surface density

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