The relations between wear behavior and basic material properties of graphene-based materials reinforced ultrahigh molecular weight polyethylene

ABSTRACT

This article aims to investigate the influence of reinforcing graphene oxide (GO) and graphite flakes (GF) fillers into ultrahigh molecular weight polyethylene (UHMWPE) for orthopedic application. These fillers were expected to physically bond to UHMWPE, thus can enhance the subsurface strength, improving the wear behavior of the composites. UHMWPE/GO and UHMWPE/GF composites were prepared at 0.1 and 1.0 wt% by melt-blending, followed by a compression molding technique. A multidirectional pin-on-disc wear test was performed to simulate the kinematic of hip application. Whilst getting exposed in the artificial in-vivo lubricant bath (30 v/v% diluted bovine serum). Following this, the wear mechanism fostered by each filler (GO and GF) was determined by wear features obtained from the optical microscope and scanning electron microscope (SEM). The crystallinity degree and crystal defect were assessed using x-ray diffraction (XRD). The mechanical properties of fabricated composites were evaluated by using a universal testing machine and Vickers microhardness. We found that UHMWPE/GO has the lowest specific wear rate due to the improved subsurface strength, as the reduction of a weak adhesive point was observed on the worn surface. Meanwhile, higher GF content (1 wt%) in UHMWPE displayed a lower specific wear rate than neat UHMWPE after completing the 10 km sliding distance attributed to the filler resurfaced, responsible for providing a strong resistance of the shear stress applied upon sliding with the metal counterface. Interestingly, the hardness and tensile strength for both UHMWPE/GO and UHMWPE/GF increased, although the crystallinity percentage was declining compared to neat UHMWPE.

Keyword: Wear behaviour; Graphene-based materials; Ultrahigh molecular weight polyethylene