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A novel bio nano-composite for biomedical application

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Hip and knee replacements are amongst the most frequent performed surgical operations. In the majority of such artificial joints, UHWMPE has been employed as one of the counter faces because of its biocompatibility and wear rate. However, where the complementary component to the UHWMPE is metal then excessive wear debris can be generated mainly due to scratching. Wear debris induced osteolysis is a major cause of long-term failure of total hip replacement.

Objective: To develop and explore novel high strength and wear resistant biocomposites based on ultrahigh molecular weight polyethylene matrix reinforced with CNTs and nano-hydroxyapatite.

Material and method: Carbon nanotubes (CNTs) exhibit exceptional physical and chemical properties due to their nano-scale dimensions. CNTs also have very high aspect ratio which makes them an excellent reinforcement material for polymer composites. The ideal reinforcement material would impart mechanical integrity to the composite at high loadings, without diminishing its bioactivity. Hydroxyapatite (HA) is the prime constituent of bone generation because of its ability to bond chemically with living bone tissues and positively affect the osteoblasts; this is due to its similar chemical composition and crystal structure to apatite in the human skeletal system. Ultra high molecular weight polyethylene (UHMWPE) is already used as implant material in high stress bearing areas such as hip and knee prosthesis but its low mechanical strength makes the use of UHMWPE problematic.

Solvent casting and melt blending methods was used during the preparation of this bio nano-composite.

The phase compositions and the surface morphology of the nanocomposite material have been studied using X-ray diffraction (XRD), scanning electron microscopy (FE-SEM), and micro-Raman spectroscopy. Nanoindentation technique was used to determine the elastic modulus and hardness of the nanocomposites with wide range of MWCNT concentrations. The tribologic behaviour of this bio nano-composite was studied using pin-on-plate method. Wear and friction of the produced bio nano-composites were studied in different biological lubrications.