

SYNTHESIS OF AlCuFe QUASICRYSTAL/POLYMER COMPOSITES

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Ultrahigh molecular weight polyethylene (UHMWPE) is used in orthopaedic implants due to outstanding wear properties. In spite of the low wear behaviour of UHMWPE compared to other polymers, wear remains a major problem in total joint replacements. Submicron wear particles cause foreign body response leading to bone resorption (osteolysis) and loosening of implant components. This further limits the life expectancy of hip prostheses [1-2]. Therefore, improving the wear resistance of UHMWPE can substantially extend the clinical life span of total hip prostheses. It was recently reported that quasicrystalline fillers may significantly improve wear resistance in polymer-based composites [3-4].

Since the discovery of icosahedral phases in rapidly-quenched Al-Mn alloys [5], quasicrystals (QCs) were observed in over 100 alloy systems. Among them, the ternary Al-Cu-Fe alloy is most interesting [6-9], thanks to excellent properties, such as the low electrical and thermal conductivity, high hardness, low friction and wear, and good oxidation resistance.

In this work polymer composites of Al-Cu-Fe quasicrystal and polyethylene were synthesized. The nanocrystalline Al-Cu-Fe powders were prepared by mechanical alloying (MA). Wet-milling in hexane was employed to counteract severe powder losses, to avoid contamination from grinding media and prevent oxidation effects.

The formation of the quasicrystalline phase during isothermal annealing of the prepared Al-Cu-Fe nanopowders at temperatures between 700-800°C was studied by differential scanning calorimetry (DSC). The annealed powders were characterized by X-ray diffraction analysis using a D8 GADDS diffractometer (Bruker AXS) using monochromatic Cu K_α radiation.

Mixtures of polyethylene and Al-Cu-Fe powders (were weighted, added together with a solvent and mixed. The resulting Al-Cu-Fe/UHMWPE mixture was dried at room temperature, then shaped into disk pellets by uniaxial pressing.

Our preliminary results show that quasicrystal/UHMWPE composites with a highly uniform dispersion of AlCuFe QC nanoparticles in the polyethylene matrix can readily be achieved by wet-mixing. The resulting composite powders may further be shaped into bulk solid bodies by pressing or extrusion. Research is underway to investigate properties of the composites, like biocompatibility, mechanical response, as well as the wear and oxidation resistance.

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