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Impact of UHMWPE texture on friction and wear resistance of hip prosthesis

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Abstract. Ultra High Molecular Weight PolyEthylene (UHMWPE) is a polymer widely used in hip implants (prostheses) as a bearing surface against metal, because of its good mechanical properties and biocompatibility [1]. Nevertheless, the durability of such implants is limited because of failure resulting from osteolysis and aseptic loosening. These two phenomenons are due to the immune response of human body consecutive to the apparition of wear particles of UHMWPE with time.

Different studies investigate wear resistance of UHMWPE by acting on its chemical structure. It has been shown, in both laboratory and clinical studies, that increasing cross-linking by irradiation considerably improves the wear resistance [2]. However this irradiation creates free radicals that react with oxygen; this oxidation in turn impacts on mechanical and chemical properties (lower molecular weight, brittleness (whitening), decreasing of toughness, ductility and fatigue cracks propagation resistance), partly decreasing the benefit from irradiation on wear resistance. [3] Other authors studied the microstructure modifications of UHMWPE: it has been shown that increasing the crystallinity by high pressure during processing is favorable to fatigue crack propagation resistance; thus, increasing both crystallinity and cross-linking improve the mechanical properties and wear resistance [4].

Another promising path of wear resistance improvement is acting on UHMWPE microstructure during the fabrication process by plastic strain. Directly linked to this project, the work presented here will focus on the study of wear resistance of a UHMWPE microstructured by such a process.

The microstructure modification will be made through uniaxial tension and cold rolling, without altering its chemistry. Hence the polymer's durability can be enhanced significantly without compromising its inherent biocompatibility.

The links between the microstructure, its impacts on the physico-chemical properties, and the wear properties of microstructured UHMWPE will be studied by an extensive characterization of the physico-chemical properties of the microstructured UHMWPE, before and after wear simulation.

References

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