DocMASE Project Proposal 2012-03

Project Title	***Mapping of Wear particles distribution of novel UHMWPE nanocomposites in Biological Environment***
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Project Description	**Project Background:** Ultra high molecular weight polyethylene (UHMWPE) has been extensively used as a bearing surface in total joint replacement (TJR). Excellent energy absorption, good wettability and low coefficient of friction as well as other mechanical properties, such as tensile, impact and creep behavior, make UHMWPE suitable as a counterface material in total TJR [1]. However, its degradative oxidation behavior leads to high wear characteristics and therefore it can contribute directly to the development of aseptic loosening [2]. Macrophages phagocytose particles in the 0.1 to 10 μm size range lead to the release of osteolytic cytokines, which results in bone resorption, followed by loosening and failure of the prosthesis [3,4]. The synovial fluid (SF) of joints normally functions as a biological lubricant, providing low-friction and low-wear properties to articulating cartilage surfaces through the putative contributions of proteins such as hyaluronic acid (HA). Wear particles flow and distribute via synovial fluid through body. Surface chemistry, size and shape distribution are important factors affecting particles distribution and cell- uptake process. How nano-sized wear particles will transports and how cells react toward them are important questions to be addressed in the present research project[5]. **The goals and scope of this PhD-project are following;** 1. The micro-particle image velocimetry (μPIV) measurement will be applied to study the synovial fluid velocity profile in small geometry and the radial migration of different wear particles. 2. The biocompatibility of wear particles from bio nano-composites versus virgin UHMWPE, will be investigated. 3. Experimentally examination of what happened to nanoparticles (reinforcements, MWCNTS, graphene oxide and nano-hydroxyapatite) after the wear debris disperse in the synovial fluid and transports to other organs. Would they stay in composite form or release in particle form in the body is an important fact to investigate through optical characterization of the bio nano-composites wear debris. 4. Effect of different proteins such as hyaluronic acid (HA) on particle transportation experimentally will be investigated too. 5. A mathematical model for dynamic flow of nano-sized wear particles (in non-Newtonian lubricant, e.g., synovial fluid) and nano-sized wear particles transport through cell walls will be also developed. **Connection to on-going projects:** Our research group in biotribology has focus on development of "Orthopaedics materials" and this project fits very well in the scope.
References	1. Slouf M, Eklova S, Kumstatova J, et al. Isolation, characterization and quantification of polyethylene wear debris from periprosthetic tissues around total joint replacements. *Wear* 2007;262:1171-1181. 2. Purdue PE, Koulouvaris P, Nestor BJ, Sculco TP. The central role of wear debris in periprosthetic osteolysis. *HSS J* 2006;2:102-113. 3. Amstutz HC, Campbell P, Clarke IC. Mechanical and clinical significance of wear debris induced osteolysis. *Clinical Orthopaedics and Related Research* 1991; 276:7-17. 4. Ingham E, Fisher J. Biological reactions to wear debris in total joint replacement. Proc Instn Mech Engrs.Part H.2000;214:21-37
Previous Publications	5. N. Emami "Biotribology behaviour of reinforced UHMWPE" ". 3rd ANM. 12-15 September, 2010