CT2M
Center for Mechanical and Materials Technologies

Scientific Interaction Meetings

Meeting nº 11

2008.05.14 – 14:00-15:00

Room: B1.13

Agenda:

14:00 : Lenuta Mazare, Mechanical and Metallurgical Characterization of Functionally Graded Based Gold Alloys
14:30 : João Lima Lopes, Friction Behaviour of Hydrogels for Artificial Cartilage

1. Mechanical and metallurgical characterization of functionally graded based gold alloys (L. Mazare (mazare_lenuta@yahoo.com), D. Soares, and F. S. Silva)

Abstract: The Incremental Melting and Solidification Process (IMSP) is a new processing technique. The operation principle can be described as follows: the materials are melt by the induction heating in the mould and the continual granules or powders of conducting materials are fed to the mould.
Incremental Melting and Solidification Process (IMSP) is being assessed and developed at Minho University, and objective is to obtain a sample with a changeover in chemical composition and a controlled colour gradient along the piece. IMSP is a relatively new field for material processing for the production of functionally graded materials. Not many experiences exist on the use of this technique to produce Functionally Graded Materials with a changing of the chemical composition along the piece. There are, recently, some experiences with a steel composite material and other alloys. Because of few experiences on the parameters of the IMSP, the process is obviously not well established yet, and mainly, not well explored in different materials.

In this process a controlled liquid bath is maintained at the top of the component where new materials are added allowing the change of the component chemical composition. Thus, a functionally graded material is obtained with a varying composition along one direction of the component. The IMSP proceeds from the bottom to the top of the mould by changing the relative position between the mould and the heating apparatus.

Due to the possibility of having local controlled properties, the aim is the production and characterization of an entirely new concept of materials design that may respond to different conditions and environments and tailored according to the different local solicitations imposed when used in a particular application. In this work we have attempted to understand the influence of the process parameters, namely: cooling rate, displacement speed between heating coil and mould in order to evaluate its influence on both metallurgical and mechanical properties of different alloys.
As some applications require different materials with different properties in different locations it is necessary to understand how the metallurgical properties will evolve throughout the gradation and what properties, either mechanical, chemical or physical, will arise from the gradient.

Results demonstrate that a gradual variation of metallurgical and mechanical properties along the

component is obtained and that the cooling rate and displacement speed are very important on metallurgical and mechanical properties of the obtained alloy.

2. Friction Behaviour of Hydrogels for Artificial Cartilage (João Lima Lopes - jll@isep.ipp.pt)

Abstract: Osteochondral defects either caused by pathologic agents or due to trauma affect about 1/3 of the population above the 30 years of age. Osteoarthritis (OA) alone, is currently the major disorder of the musculoskeletal system leading to articular cartilage degradation, affecting over 85% of the population by the age of 75, and to some extent, the majority of the population over the age of 65. OA is debilitating and prevalent besides costly, and the destruction mechanisms involved are not well understood.

Articular cartilage has very low capability of spontaneous self-regeneration mainly because of its avascular nature; being an aneural tissue, small lesions may evolve without being detected, reducing the alternatives to a non-arthroplastic solution.

Polymeric hydrogels have been extensively used for various biomedical applications - molecular imprinting, wound dressing materials, immunoisolation, drug delivery systems and tissue engineering. Recently, there has been a growing interest in the potential use of these materials for the repair and regeneration of osteochondral defects, mainly due to their ability to provide a good conciliation between rigidity and water content. This study evaluates the friction behaviour of poly(2-hydroxyethylmethacrylate-co-methylmetacrylate) (HEMA-co-MMA) copolymer hydrogels in reciprocating sliding. The hydrogels were obtained by adding an initiator, azo-bisisobutyronitrile (AIBN) to HEMA and MMA monomers, followed by 20 hour oven curing in Teflon moulds. Several HEMA (2-hydroxyethylmethacrylate) / MMA (methylmetacrylate) ratios were used. The tests were performed using a pin on flat geometry, in the presence of PBS (phosphate buffered saline) acting as the lubricating media. The frequency of the oscillatory motion was 1 Hz and the stroke length of 8 mm. The normal load applied assumed the values ranging from 5 N to 40 N. The moving plate consisted in flat bovine articular cartilage (BAC), sliding against a flat tipped cylinder of either hydrogel or BAC, for tests involving dissimilar or for self mated pairs, respectively. The friction coefficient, μ, obtained for self-mated BAC tests were higher than those found in the literature (0.002 – 0.03). The friction values obtained for dissimilar pairs have not shown a clear correlation with the HEMA content of the hydrogel, however, the lower μ values corresponded to the hydrogels with higher HEMA content. For both tribosystems (self-mated BAC and BAC-hydrogel) the test duration indicated that the measured μ values relate to the steady-state, which might rank poly(HEMA-co-MMA) hydrogels as good candidates for repair material of small articular cartilage lesions.