CT2M
Center for Mechanical and Materials Technologies

Scientific Interaction Meetings

Meeting nº 3

2007.11.21 – 14-15h

Room: B1.13

Agenda:

14h – Alexandra Alves, Bio-compatibility and tribocorrosion behaviour of modified titanium surfaces: Dental applications
14h30 – Georgel Maricel CHIRITA, Mechanical and Fatigue Properties of Cast and Functionally Graded Aluminium Silicon Alloys

Thank you for your co-operation during last two SIM sessions, which is gradually becoming a remarkable event for all the researchers at the CT2M, for the scientific interactions and exchange/gather new views/thoughts. All are welcome to the 3rd session on 21st November 2007. The more details of the above presentations are as follows,

1. Bio-compatibility and Tribocorrosion behaviour of modified Titanium Surface: Dental application, by Alexandra Alves (alexandra@dem.uminho.pt)

Abstract: Proceeding from first clinical applications in 1951, titanium and its alloys have in recent years become increasingly established as metallic biomaterials, namely in dental implants. The main reasons for the extensive and increasing use of these materials are due to their excellent mechanical properties, corrosion behavior and biocompatibility. It is well known that under the atmospheric conditions the titanium surface is always covered by an oxide layer. This layer is protective and stable that is being defended as the responsible for the good *in vivo* performance.
Lately, the role of roughness and surface topography have been discussed because of their importance in cell and tissue response, once that this response is not just affected by the chemical properties of the implant surface. Also, the tribological properties of the surface of the dental implant become important because micro-sliding between the implant and the adjacent tissues may occur. However it is known that titanium and its alloys have poor wear resistance, and it is important to refer that a dental material is in contact with aggressive chemical media. In this way the synergy action of the wear and corrosion processes (tribocorrosion) becomes important. These tribological properties can be improved by surface modification which can also improve the biological compatibility of the materials.
An anodic treatment has a few advantages concerning other surface treatment methods of titanium. When this method is used there is no need of a special apparatus and it can be adapted to any shaped titanium, and an uniform oxide film is formed on the whole surface. The biocompatibility of titanium depends on the surface chemical composition and the ability of titanium oxide to adsorb molecules and incorporate elements[9], therefore the presence of specific Ca/P ratios are known to benefit this biocompatibility, which is why a solution of β-GP+CA is used.
The main aim of this work is to study the influence of the different parameters of the anodic treatment on the tribocorrosion behaviour and osteointegration capability of titanium for

dental implants applications. Tribocorrosion mechanisms, under sliding conditions, in contact with HBS solution will be investigated, and cell culture will be done to study the cell adhesion on the surface that was modified by the anodic treatment.

2. Mechanical and Fatigue Properties of Cast and Functionally Graded Aluminium Silicon Alloys, by *Georgel Maricel CHIRITA (george@dem.uminho.pt)*

ABSTRACT: The research on functionally graded materials (FGMs) is encouraged by the need for properties that are unavailable in any single material and the need for graded properties to offset adverse effects of discontinuities for layered materials. Centrifugal casting is a very common method for obtaining functionally graded materials, mainly composite materials or metallic materials which has high differences of density and low solubility on different phases or different materials of the same alloy. The present work is emphasizing the fact that the centrifugal process could be successfully used for obtaining functionally graded materials also for metallic materials (alloys) with high solubility and small differences of density of the different phases, as is the case of most aluminium alloys.

The first approach of the problem was to isolate the effects of the centrifugal casting technique (the centrifugal pressure effect, the fluid dynamics and the inherent vibration effects) in order to identify the reason of mechanical properties improving. In order to have a reference for comparison, castings obtained by both centrifugal casting technique and gravity casting technique were tested. To isolate the vibration effect an experimental equipment was designed and constructed in order to be able to cast within a certain level of vibration equivalent with the vibration level of the centrifugal casting equipment. The results are confirming that there is a correlation of improving mechanical properties with the vibration of the melt during solidification. The difference of the mechanical properties of castings obtained by gravity technique and by centrifugal casting technique could be explained by the fact that, the vibration and the fluid dynamics due to the inherently vibration of the equipment and respectively due to the centrifugal pressure make the melt during solidification to initiate more nuclei of solidification. Then, the centrifugal pressure might move the nuclei of solidification to the furthest point of the mould (where the pressure is higher) fact that explains the obtained results which are higher on one side of the ingots which corresponds with the side of the mould where the pressure is higher and smaller on the other side where the pressure is smaller. Actually the composition is graded on centrifugal direction which provides also graded properties.

The mechanical and fatigue properties are largely influenced by the presence of material inhomogeneities. Inclusions or secondary phase particles are common sites for fatigue crack nucleation in aluminium alloys. The constituent particle's size and shape are important characteristics that influence crack nucleation. This study intends to assess also the problem of fatigue life prediction by establishing a relation within some of the characteristics of the micro structural features of studied aluminium silicon alloys such as secondary dendrites arm spacing (SDAS), volume fractions of phases (a-Al phase, eutectic and intermetallic phases), the size of silicon lamellas in interdendritic eutectic regions and the size and shape of silicon particles.