Predictive Models for Tissue – Implant Interaction Behavior

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A wide diversity of problems in physiological processes, including the circulation, gas exchange in the lungs, control of cell volume, the renal counter-current multiplier mechanism, and muscle mechanics were studied by means of mathematical modeling. Also, numerical methods such as FEM analysis are efficient for describing a variety of biomedical phenomena. Thus, the efforts to bring new efforts which can approach in a high extent the reality are a continuous challenge for researchers working in interdisciplinary areas.

Within the frame of this work we have started a predictive study of tissue – implant behavior when the two are in contact. When a biomedical device is implanted into the human body, several factors influence its short or long term integration. Therefore, tissue, as well as implant is affected in a certain measure. One of the first phenomena affecting the efficiency of the implantation is the adhesion tissue – implant, which can affect both tissue and implant quality. Studies presented in the past have shown that modeling of bone cells on titanium surfaces it's a procedure that can give solutions and important explanations concerning the failure of titanium implants in implant surgery. New protocols of modifying titanium surfaces were developed and proposed for creating a better environment for tissue development. Thus, the analytical model applied for titanium prosthesis, supported by experiments and lightly improved, could be applied to any kind of material and to any kind of tissue, giving a fast answer to the type of response of the implant or of the tissue after the surgery.

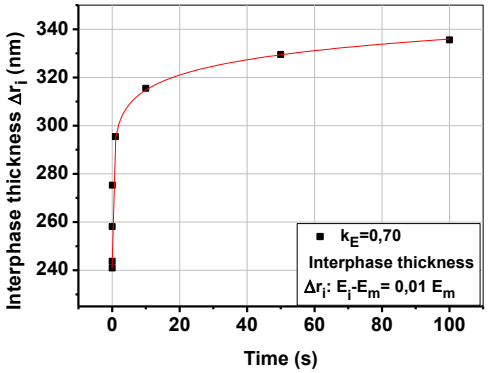
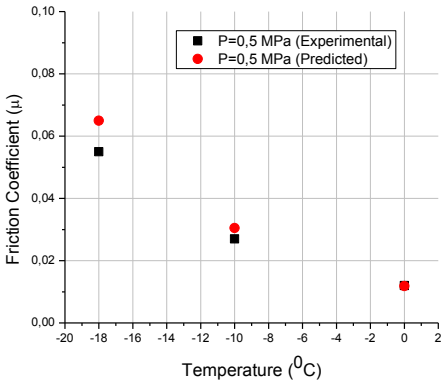


Figure 1.a) Interphase thickness formed between human osteoblasts and titanium



1.b) Friction coefficient for the TiO_2 nanotubes-ice system

A second model, which predicts the friction coefficient developed between two materials, was developed. This can give information concerning the long term efficiency of an implant, related to the friction coefficient developed between the implant and the material and the damage that can be created to the material. The model' validity was confirmed through experimental tests, using again as a material the titanium dioxide nanotubes layer in contact with ice.

The target of our future work is to create a protocol for fast, efficient and simple modeling methods applied to implants, which can exclude implant failures developed in short time after the surgery because of improper adhesion biomaterial – tissue or in long term because of degradation of the biomaterial in the physiological environment.