Crevice-corrosion of biomedical alloys in hip joints configuration

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Total hip joint arthroplasty is a medical procedure to replace a diseased joint. During the last year more than 480.000 replacements were done in countries as Australia. Nowadays, several different models of prosthesis are implanted being the modular designs popular due to all benefits that they brought in terms of mobility, pain reduction and correct tailoring to the body of each patient. However, this modularity has been related to several health complications such as high levels of released metal ions in blood and adverse tissue reaction, among others.

Several degradation mechanisms, such as fretting-corrosion, crevice-corrosion, galvanic coupling, among others have been invoked to explain those health complications. According to the geometrical, mechanical and electrochemical conditions affecting hip joint prothesis, is clear that fretting-corrosion is the main deterioration mechanism. However, many aspects about crevice-corrosion occurrence on biomedical alloys are still unclear.

This work proposes an experimental and theoretical approach to clarify under which geometrical, electrochemical and chemical conditions, crevice-corrosion can take place in modular hip joint implants configuration. A geometry mimicking head/neck configuration was designed and tested with a sensitive material to this corrosion phenomena. Crevice-corrosion degradation was generated in less than 48 hours. Biomedical alloys were evaluated as well in this configuration, under different electrochemical and chemical conditions. After 30 days of test, no damage was registered.

In addition, an existing model predicting crevice-corrosion occurrence is analyzed and validated to be used in modular hip joint configuration. Finally, experimental and theoretical results are compared to validate the proposed approach.