# Potentially cytotoxic organometallic compounds formed in cartilage sliding against partial implants unveiled by in vitro experiments

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The present study shows the formation of potentially cytotoxic organocobalt compounds during reciprocating sliding of bovine osteochondral plugs against CoCrMo using *in vitro* experiments. The experiments were performed in an electrochemical cell coupled to a microtribometer under controlled electrochemical conditions. The results show a systematic drop of the open circuit potential at the onset of sliding. This drop is attributed to changes in the passive layer on the metal surface which leads to Co release. Mass spectrometry analyses revealed that Co was found in form of organometallic complexes with amino acids.

**Keywords:** biotribology, cartilage, tribocorrosion, metal ion release

## 1. Introduction

Partial replacements were introduced to the market during the last decades and used for resurfacing defected cartilage tissue. As a less aggressive alternative to full replacement surgery they, on the one hand, have the aim of boosting patient recovery and increase their quality of life. On the other hand, it has been widely observed that the remaining native cartilage left after hemiarthroplasty, total knee arthroplasty without patella resurfacing and other partial resurfacing procedures which create a metal-on-cartilage interface, experiences accelerated wear when in contact against metallic implants [1]. The aim of present study is to address the role of bio-tribocorrision using CoCrMo alloy during sliding contact against bovine cartilage, with emphasis on Cobalt (Co) release during rubbing.

## 2. Methods

The microtribometer experiments on bovine osteochondral plugs in reciprocating sliding against CoCrMo implant material were performed using a FALEX®-MUST rig coupled to a three-electrode electrochemical cell (Figure 1). Phosphate buffered saline solution was used as an electrolyte. Throughout the experiment, the coefficient of friction and the open circuit potential were monitored. Afterwards, the electrolyte was analyzed using Inductively Coupled Plasma (ICP) in order to measure the amount of released Co and correlate it with the frictional behavior. The molecules present on the cartilage surface after the experiment were unveiled using mass spectrometry (Figure 1).

## 3. Results and Discussion

The coefficient of friction reached the values between 0.02 and 0.05 depending on the testing conditions. The results showed the occurrence of biotribocorrosion during sliding between a CoCrMo alloy and bovine articular cartilage. An approximately 5 mV drop in open circuit potential was consistently observed at the onset of sliding. The potential drop indicates changes in passive layer of the CoCrMo alloy, which led to metal release. Co concentrations of up to 22 ppb were measured along with the presence of Co and Cr compounds on the cartilage surface. Co was found in form of organometallic complexes with amino acids while Cr was identified with several oxidation states, including cytotoxic hexavalent Cr [2]. The concentration of metal after the experiment depended on the applied normal load and sliding velocities [3].

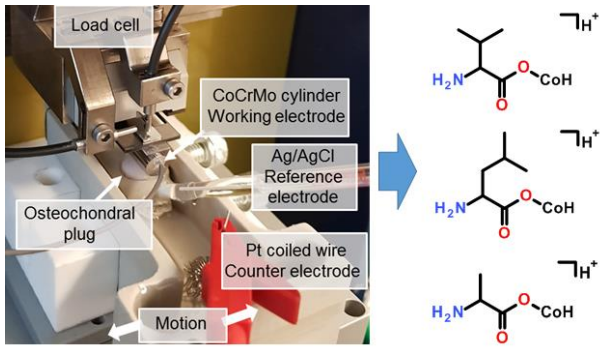


Figure 1: Tribocorrosion set-up (left) and organocobalt compounds identified after the experiment (right)

## 4. Acknowledgments

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