Galvanic Corrosion Testing

The 2.7 mm and 3.5 mm screws included in various Acumed systems are composed of cobalt-chrome (CoCr) alloy and are used with Acumed plates consisting of titanium alloy and commercially pure titanium.

Dissimilar metals in contact in an electrolyte solution may initiate an electrochemical process known as galvanic corrosion, where one metal corrodes another as a result of an electropotential difference between the metals.[1] Galvanic corrosion manifests as accelerated corrosion of the more active, corroding metal (anode), and slower corrosion of the more noble metal, if it corrodes at all.[1]

There is significant research on the safe use of CoCr and titanium in the body. Both CoCr and titanium are self-passivating, indicating that these materials tend not to have galvanic interactions over time.[1] Kummer et al previously demonstrated that CoCr-titanium couples result in low, stable galvanic currents that gradually decrease over time.[2] A number of orthopaedic device manufacturers are currently using CoCr screws and titanium plates in the same combination as Acumed.

In order to quantify the potential impact of galvanic corrosion on Acumed's CoCr, third-party testing was completed. The corrosion rate and mass loss for each sample couple was determined and used to calculate material release.

Summary of Galvanic Couple Current Data for Screw Platform Materials (CoCr, Titanium Alloy, Commercially Pure Titanium)

Average results of testing each titanium material (cathode) in presence of CoCr material (anode)

Corrosion Rate (CR) Mils Per Year (mpy)[3]	Mass Loss (MR) (µg/cm²/day)	Calculated Material Release (µg/day)
0.001	0.04	0.07

Source: Acumed Internal Test Report TR01671

The calculated corrosion rate (CR) was less than 0.001 mpy. The MR was less than 0.04 µg/cm²/day. For these cobalt-chrome screws, with a surface area of 1.63 cm², this translates to less than 0.07 µg/day of cobalt-chrome material released.

In addition to the corrosion rate, mass loss, and calculated material release, the cobalt-chrome screws were examined pre- and post-testing at up to 40X magnification to assess their general condition. This examination revealed no pitting or indication of corrosion.

Acumed's findings are consistent with those in the research literature that showed that CoCr and titanium alloys generate a finite current, ultimately resulting in a stable passive film, limiting material loss to nearly undetectable levels.[2] It has been verified that no appreciable galvanic corrosion occurs between CoCr screws and Ti plates.

1. Urish K, Anderson P, Mihalko W and the AAOS Biomedical Engineering Committee. The challenge of corrosion in orthopaedic implants. *AAOS Now.* April 2013.

2. Kummer FJ, Rose RM. Corrosion of titanium/cobalt-chromium alloy couples. *J Bone Joint Surg Am.* 1983 Oct;65(8):1125-6.

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