In-vivo Degradation Kinetic of Magnesium Implants

F. Witte, H.-A. Crostack[1], J. Nellesen[1], J. Fischer and F. Beckmann[2,3]

Dept.. of Orthopaedic Surgery of Medical School Hannover, Anna-von-Borries-Str. 1-7,30625 Hannover, Germany

[1]Lehrstuhl für Qualitätswesen of University Dortmund, Joseph-von-Fraunhofer Str. 20,44227 Dortmund, Germany

[2]GKSS-Forschungszentrum Geesthacht, Max-Planck-Straße 1, 21502 Geesthacht, Germany

[3]Hamburger Synchrotronstrahlungslabor at Deutschen Elektronensynchrotron, Notkestr. 85,22603 Hamburg, Germany

Temporary bone implants made of magnesium alloys degrade in bone [1]. This degradation is predicted to be a corrosion process. The corrosion of magnesium alloys is depending on its environment, the elemental composition of the magnesium alloy and its processing treatment. The corrosion can also be controlled by surface coating. Basic principles of magnesium corrosion in bone could be demonstrated in animal studies [2].

In preliminary studies casted magnesium alloys were used that were chilled to pins and were applied as bone implants [2]. These implants showed a local and high corrosion attack at the implant surface. In a new approach to more corrosion resistant magnesium alloys the base material was extruded and chilled to little cylinders. The extrusion process provide a more homogenous magnesium alloy.

To observe the corrosion process in the bone histological sections are commonly used to determine the bone-implant interphase. These destructive methods effect the magnesium alloys because of its soluble nature. Therefore, the bone-implant interphase was studied by microcomputed tomography as a non-destructive method with a high spatial resolution.

In order to get an degradation kinetic of the magnesium alloy we had to determine magnesium samples postoperatively after various time intervals. Magnesium implant degradation was observed over a total postoperative time of 12 weeks, scanned in intervals of 2, 4, 6 and 12 weeks.

Bone healing and bone remodelling processes provide a high interindividual variety. Therefore, at least 5 animals at each time interval had to be studied. The magnesium cylinders were implanted in the femur condyls of the rabbits (New Zealand White Rabbits).

The micro-tomography measurements (XTM) were carried out at beamline W2 using a photon energy of 31.0 keV. The projection data contain radioscopic images consisting of 1536x692 pixels acquired at 720 rotation angles for one sample. The observation area was kept to the center of the bone specimen.

In total, 40 bone-implant samples were scanned each in two different levels. So, 80 tomograms were performed and have to be reconstructed and analyzed. The tomograms of each level were stacked together after reconstruction to observe the whole implantation site.

First results of the reconstructed data show that extruded magnesium alloys corrode at a slower rate and more homogeneously than casted magnesium alloys. Extruded magnesium alloys corrode in direct contact to the surrounding bone.

Further evaluation and complete reconstructed data are going to provide the first detailed information about the *in-vivo* degradation rate of magnesium alloys in bone.

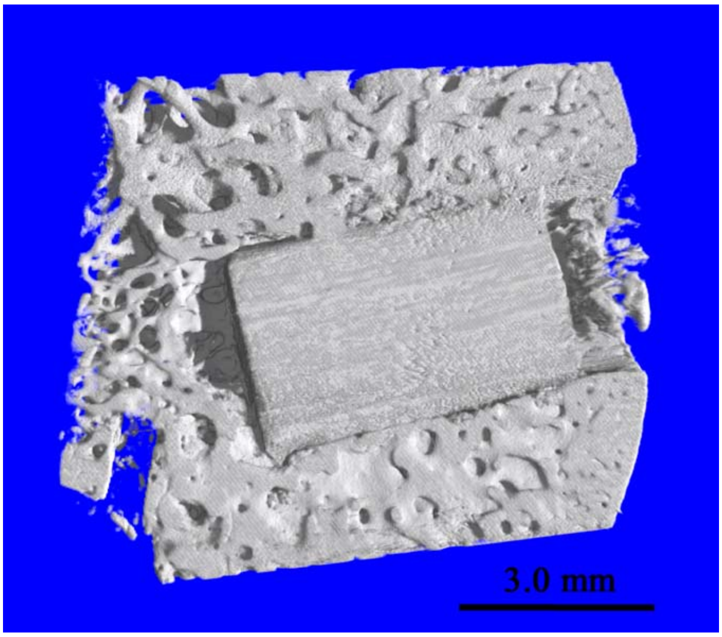

Figure 1: Magnesium implant corrodes in direct contact to surrounded bone (upper part of implant) four weeks after operation.

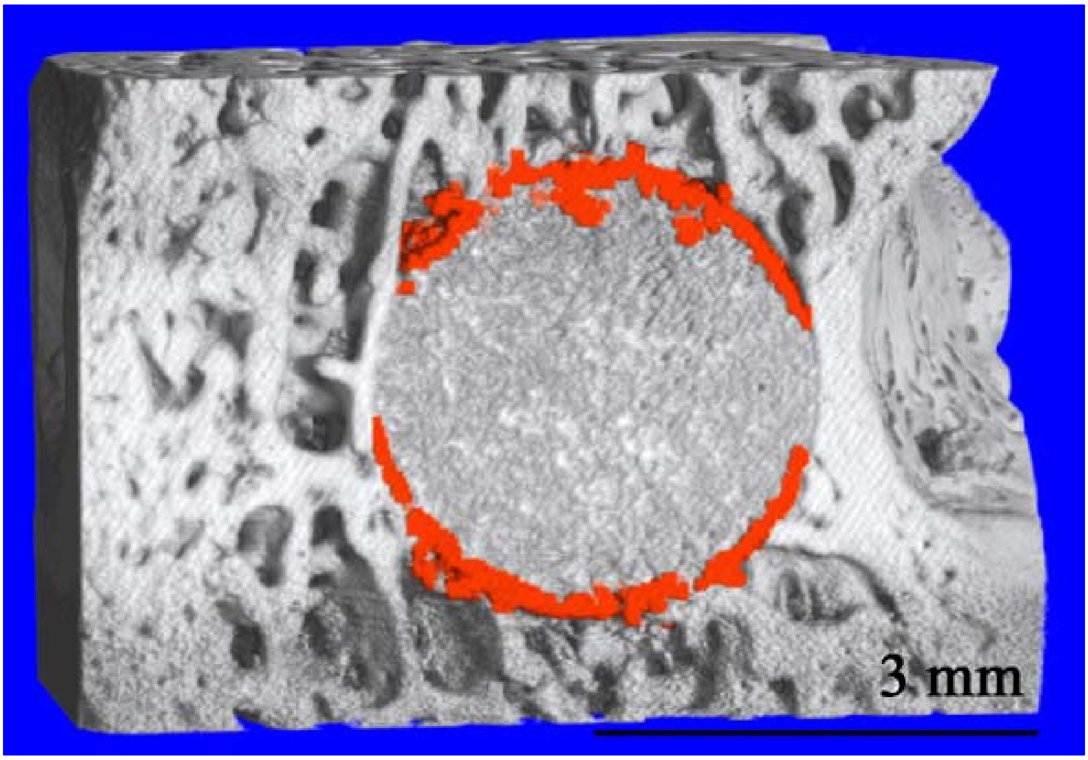

Figure 2: 3D view of corroding magnesium implant in rabbit condyl 12 weeks after operation. Red dyed grey values represent corroded magnesium alloy.

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References

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