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Using the Micro Computed Tomography to Study the Corrosion Behavior of Magnesium Alloy at Different pH Values

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Abstract : Introduction and Motivation: In recent years, magnesium alloy is used to be a kind of medical biodegradable materials. Magnesium is an essential element in the body and is efficiently excreted by the kidneys. Furthermore, the mechanical properties of magnesium alloy is closest to human bone. However, in some cases magnesium alloy corrodes so quickly that it would release hydrogen on surface of implant. The other product is hydroxide ion, it can significantly increase the local pH value. The above situations may have adverse effects on local cell functions. On the other hand, nowadays magnesium alloy corrode too fast to maintain the function of implant until the healing of tissue. Therefore, much recent research about magnesium alloy has focused on controlling the corrosion rate. The in vitro corrosion behavior of magnesium alloys is affected by many factors, and pH value is one of factors. In this study, we will study on the influence of pH value on the corrosion behavior of magnesium alloy by the Micro-CT (micro computed tomography) and other instruments.Material and methods: In the first step, we make some guiding plates for specimens of magnesium alloy AZ91 by Rapid Prototyping. The guiding plates are able to be a standard for the degradation of specimen, so that we can use it to make sure the position of specimens in the CT image. We can also simplify the conditions of degradation by the guiding plates.In the next step, we prepare the solution with different pH value. And then we put the specimens into the solution to start the corrosion test. The CT image, surface photographs and weigh are measured on every twelve hours. Results: In the primary results of the test, we make sure that CT image can be a way to quantify the corrosion behavior of magnesium alloy. Moreover we can observe the phenomenon that corrosion always start from some erosion point. It's possibly based on some defect like dislocations and the voids with high strain energy in the materials. We will deal with the raw data into Mass Loss (ML) and corrosion rate by CT image, surface photographs and weigh in the near future. Having a simple prediction, the pH value and degradation rate will be negatively correlated. And we want to find out the equation of the pH value and corrosion rate. We also have a simple test to simulate the change of the pH value in the local region. In this test the pH value will rise to 10 in a short time. Conclusion: As a biodegradable implant for the area with stagnating body fluid flow in the human body, magnesium alloy can cause the increase of local pH values and release the hydrogen. Those may damage the human cell. The purpose of this study is finding out the equation of the pH value and corrosion rate. After that we will try to find the ways to overcome the limitations of medical magnesium alloy.

Keywords : magnesium alloy, biodegradable materials, corrosion, micro-CT
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