CORROSION BEHAVIORS OF MAGNESIUM FILM COATED WITH BIOCOMPATIBLE MATERIALS UNDER PSEUDO-BIOLOGICAL ENVIRONMENT

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1. Introduction

Biomaterials are used to be embedded in the human body and classified by a period of using [1]; (a) Semi-permanently using such as the artificial heart, (b) Temporarily using such as a bone plate, and (c) Disposable using such as injection. The temporarily used biomaterials have to be removed with surgery after the complete recovery and it imposes expensive surgery and physical and mental pains to the patients. Recently, the application of magnesium (Mg) for bio-implant material has been interested because of its biodegradable, mechanical strength as much as bone and low cytotoxicity. On the other hand, the corrosion resistance of Mg is less to sustain the strength until the recovery of the affected part. There is some research for solving the problem of the corrosion resistance with Mg [1-3]. Figure 1 shows the strength degrading for corrosion under a pseudo-biological environment. The black and red curves mean the strength at corrosion times of virtual and ideal biodegradable material and pure Mg, respectively. The strength of pure Mg gradually degrades for excretion in the body. The ideal corrosion behaviors have two regions, Existing period and Dissolving period. The material keeps in the body for sustaining the mechanical strength in the Existing period and then that is promptly excreted from the body in Dissolving one. This study is to develop the biocompatible material coating Mg film and evaluate the corrosion behaviors of the Mg film under the pseudo-biological environment.

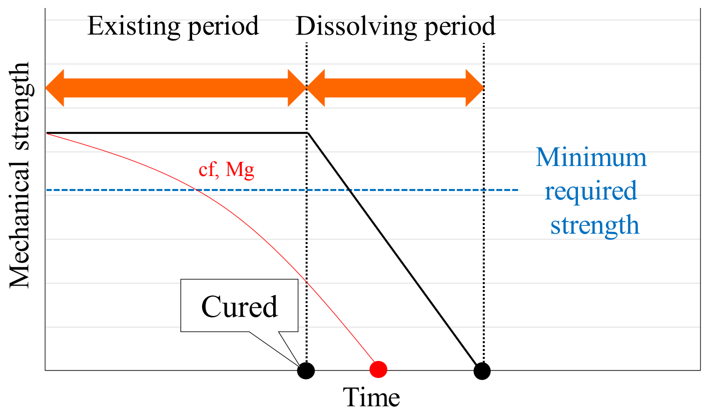

Figure 1: Mechanical strength of pure Mg and ideal biodegradable materials at corrosion times.

2. Experimental methods

The corrosion test was conducted with the Mg ribbonlike film manufactured by Nilaco Corporation. The specimen was cut from the film to a rectangular shape; 50×3.2×0.24 mm and layered with two kinds of materials, one for holding the existence of the specimen and the other for promoting the dissolution. The former material is Polylactic acid (PLA) and the latter Titanium (Ti). PLA, which has biodegradability and low cytotoxicity, was available to control the degree of the Mg film corrosion. We coated PLA provided by Unitika Corporation on the surface of the Mg film with injection molding at 513K. Ti is also a biocompatible material and its galvanic corrosion between Ti and Mg promotes the dissolution and then reduces the Dissolving period. We deposed Ti on the surface of the specimens with a heat resistance vacuum deposition method. The three kinds of the specimens were prepared and called "As-received", "Mg/PLA", and "Mg/Ti". We conducted the corrosion test to the specimens with the conditions as shown in Table 1. Then we evaluated the corrosion states with tensile test and X-ray diffractions (XRD). The tensile tests were carried out at room temperature at 0.5 mm/min. and evaluated one at before and after the corrosion test. XRDs were performed on a MiniFlex600 manufactured by Rigaku Corporation (Cu target, 40kV 15mA) with a step size 0.005° (2θ).

Hold temperature [K]	Solution	Corrosion time [h]		
310	Saline (0.9 wt% NaCl solution)	24	72	120

Table 1: Corrosion conditions.

3. Results & Discussion

In Fig.3 It was shown that the decrease of the weight of As-received and Mg/Ti (Fig.3(a)), an image of corroded Mg/Ti (Fig.3(b)), and the stress-strain curve of As-received before and after the corrosion test (Fig.3(c)). The decrease of the weight of 72h was 2.49 mg more than that of 24h. The decreased weight with 120h was 0.66 mg and less than that of 72h. We confirmed the specimen had Na on its surface according to XRD analysis, which was included in the solution, i.e., Saline. It seemed that component of the solution was coated during the corrosion progress. This Na might suppress the loss of the weight even though the corrosion. On the other hand, Mg/Ti completely dissolved after 24h due to the corrosion (Fig.3(b)). The corrosion potential between Mg and Ti is 1.6V [4] and that caused the dissolution of Mg and Ti. In the mechanical test, Fig.3(c) indicates that the stress and strain of As-received decreased 21.5 MPa and 0.311 ε with corrosion, respectively.

Figure 3: (a) The decrease of weight of As-received,(b) Corroded Mg/Ti, (c) The stress-strain curve of As-received.

4. Conclusion

Even though the mechanical strength decreased with corrosion, the corrosion products, Na suppressed the decrease of the weight of the specimen under the pseudo-biological environment. This effect might be available for controlling the times of Existing and Dissolving period.

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