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A New PCL Based Porous Membrane To Control The Degradation Of Biodegradable Metallic Materials

HM Wong,1 KWK Yeung,1 KO Lam,1 PK Chu,2 KDK Luk,1 KMC Cheung,1,*

1Division of Spine Surgery, Department of Orthopaedics and Traumatology, Queen Mary Hospital, The University of Hong Kong, Hong Kong SAR, China
2Department of Physics and Materials Science, City University of Hong Kong, Hong Kong SAR, China
(*ken-cheung@hku.hk)

In order to prevent stress shielding effects, removal of orthopaedics metallic implants after healing is required in some cases. The use of bioresorbable magnesium based alloy is therefore an alternative. However, rapid degradation and hydrogen gas release are the major obstacles. A biodegradable polymer-based-porous membrane made of polycaprolactone (PCL) and dichloromethane (DCM) has been recently fabricated by our team to control the degradation of AZ91 magnesium alloy. This study aims to investigate the in-vitro and in-vivo degradation rates of the treated and untreated magnesium alloys.

The PCL membranes were deposited on the magnesium alloy by a custom made spraying process. To simulate an in-vitro corrosion environment, simulated body fluid immersion test for 60 days was applied. The released ions were analyzed by inductively-coupled plasma mass spectrometry. To evaluate in-vivo degradation, the treated and untreated samples were implanted into the intramedullary cavity of the New Zealand White rabbits for 60 days. The degradation of implanted rods and newly formed bone were monitored and quantified by micro-computed tomography.

Severe corrosion is observed on the untreated samples in which the magnesium ions released are about 6 folds higher than the treated at day 60 under in-vitro condition. Largest volume reduction of 0.33% and smallest volume of new bone formation of 1.36 mm$^3$ are found on the untreated sample, whereas at most 0.05% volume reduction and at least 4 folds higher new bone formation are found on the treated. Both in-vitro and in-vivo studies suggested that the polymer-based-porous membrane can significantly suppress the rapid degradation of magnesium alloy.