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Application of silk as anticorrosion and antibacterial film on AZ31 magnesium alloy

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INTRODUCTION: Magnesium alloys, due to their unique properties such as intrinsic antibacterial behaviour, similar density to human bone, natural biodegradability, etc. can be optimal option for orthopaedic applications. However, poor corrosion resistance of Mg alloys is the main hurdle for their practical application. Here, the surface of AZ31 alloy was coated with silk to be protected from corrosion in simulated body fluid (SBF) and biomimicked nanocones were introduced to the surface of silk film to enhance the antibacterial properties.
METHODS: Silk cocoons were boiled for 30 minutes in water solution with 0.02 M Na2CO3 and washed afterward, followed by dissolving in 9.3M LiBr solution and then dialyzed for 48 h. AZ31 substrates were spin-coated with silk solution and nanocones were fabricated on the surface of silk film via colloidal lithography and oxygen-plasma etching. SEM, FTIR, Raman spectroscopy, AFM, electrochemical impedance spectroscopy, potentiodynamic polarization and adhesion tests were done to characterize the platform. Agar plate counting and live/dead staining methods were used to assess antibacterial properties of samples against E. coli and S. aureus bacteria strains while live/dead staining of MC3T3 cells was used to show biocompatibility of the platform.
RESULTS: Nanopatterns with 400 and 300 nm, height and centre-to-centre distance, respectively, was fabricated on the silk film. This film increases corrosion properties significantly (near to 104 times) by decreasing corrosion current from 79µA/cm2 to 0.01µA/cm2 and increasing the corrosion potential from -1.58V to -0.78V. The immersion test results showed that weight loss of Mg alloy was decreased around 50% after 1 day and the similar trend was seen for Mg ions leaching. β-sheets in silk, which are responsible for the good corrosion behaviour, started to deteriorate after 1 day, detected by FTIR and Raman spectroscopy. Antibacterial properties of Mg alloys stemmed from releasing Mg ions and by improving in corrosion properties of the alloy, there would be a loss in its antibacterial properties. Here, nanocones compensated this lack and in overall, enhance both corrosion and antibacterial properties. Also, by decreasing the amount of leached Mg ions and consequently pH of medium, cytotoxicity of platform was decreased and less cells were died due to high alkalinity of the medium.
DISCUSSION & CONCLUSIONS: Introducing nanopatterned silk film as a coating on the surface of AZ31 magnesium alloy, significantly enhanced its corrosion properties while successfully counteract the loss of inherent antibacterial characteristics of the AZ31 due to lesser Mg ions leaching.

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