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Formation of Natural Polyelectrolyte Layer by Layer (LBL) coating on Magnesium Alloy

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Magnesium (Mg) and its alloys are being investigated for its use as biodegradable metallic scaffold for bone tissue engineering applications [1]. Magnesium based implants degrade in physiological conditions in vivo and form soluble, nontoxic magnesium chloride that is harmlessly excreted in the urine [2]. It is hypothesized that magnesium and its alloys could be applied as a lightweight degradable, load bearing metallic scaffolds for bone tissue engineering applications. The scaffold would remain in the body and maintain its mechanical integrity over a predetermined time scale and then eventually biodegrade and be replaced by the growing bone tissue. However for magnesium to serve as a viable metallic scaffold material, surface modification strategies are needed to create a matrix on the surface of magnesium alloy which will be able to support the growth and differentiation of cells.

Layer by Layer (LBL) assembly is a simple and effective way to form a porous coating on a surface. It is an inexpensive method and the layers thickness could be varied from nanometers to low micrometers range which makes them very customizable. In 1991, Decher et al., reported the stepwise immersion of substrates such as mica and glass into aqueous solutions of positively and negatively charged polymers and produced multilayered ultra-thin polymer films with controllable nanometer thickness [3]. This method is called LBL assembly. Over years researchers have extended this technique to include deposition of proteins, metal nanoparticles, nanospheres. In the beginning only electrostatic interactions were utilized for LBL assembly. Subsequently, other interactions such as covalent bond, hydrogen boning, charge transfer, hydrophobic and coordination bond interactions have been investigated to facilitate the ultrathin film deposition [4]. It is known that surfaces such as metal oxides or other hydroxyl / carboxyl terminated surfaces have a net negative charge in solution because of surface oxidation and hydrolysis and can be used as effective substrates for LBL assembly [4].

In this work we have demonstrated the formation of natural polyelectrolyte layer by layer (LBL) coating on magnesium alloy. The formation process is schematically represented in figure 1. Samples of Magnesium alloy AZ31 were obtained and washed with Micro 90 solution for 2-3 minutes. Four beakers were set up shown in figure 1. Carboxy methyl cellulose (CMC) and Pectin polymers were selected as the polymer system for feasibility studies. The Mg substrate was sequentially dipped in polymers solution while being rinsed and washed between polymer dipping. The films was then be characterized for surface topography using scanning electron microscopy (SEM).

SEM characterization of the surfaces before and after LBL assembly clearly shows the formation and presence of the LBL layer. Presence of irregularities and cracks on the surface are indication of the layers being non uniform and non-ordered in nature, thus they could provide a porous substrate when in contact with cell media and could be potentially used as a matrix for cell growth.

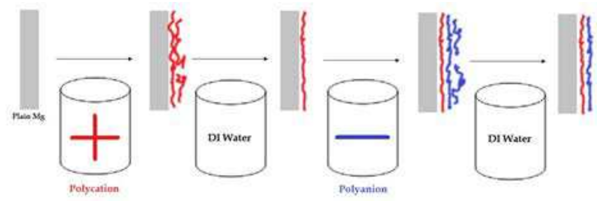

Figure 1: Schematic representation of LBL assembly

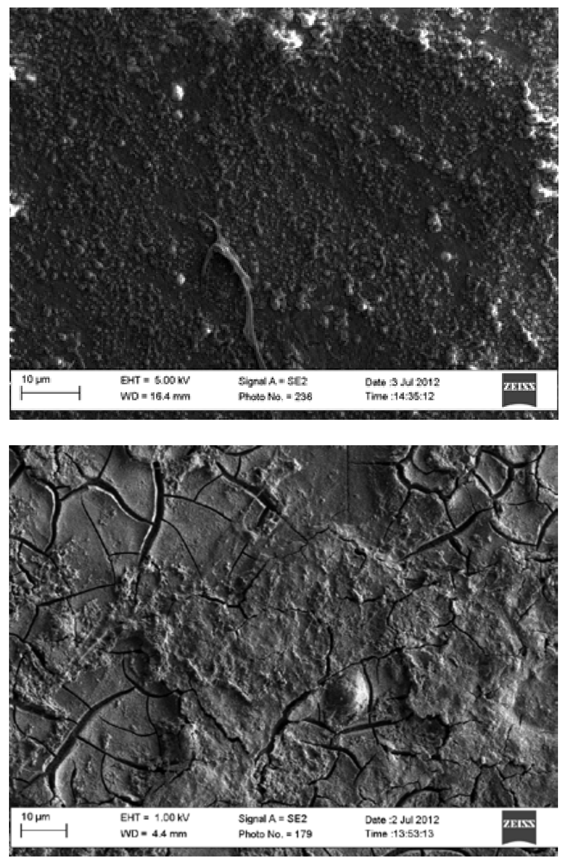

Figure 2: SEM Images of bare Mg sample (top) and LBL coated Mg sample (bottom)

In summary we have demonstrated the formation of LBL assembly of natural polyelectrolytes on Mg alloy.

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