Surface morphology dependent electrochemical properties of dysprosium-magnesium-zinc alloy thin films

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A ternary Dy-Mg-Zn combinatorial material library has been prepared from pure elements using thermal evaporation. Scanning energy dispersive x-ray spectroscopy (SEDX) measurements showed a composition gradient for Dy from 2.5 – 0 at%, for Mg from 91 – 55 at% and for Zn from 44 – 9 at%. No visible reflexes in the Mg rich region could be found. Small signals occurred in Mg poor areas. Scanning electron microscopy (SEM) images displayed a topographical change from flakes to grains by increasing Zn content and simultaneously a flattening by increasing Dy content. Electrochemical impedance spectroscopy (EIS), polarisation curves and cyclic voltammetry (CV) measurements have been conducted using scanning droplet cell microscopy (SDCM) coupled to an inductively coupled plasma spectrometer (ICP-OES) to measure the electrochemical properties and the resulting dissolution of dysprosium, magnesium and zinc ions simultaneously. Modified simulated body fluid ($SrCl_2$ instead of $MgCl_2$) was used as electrolyte to imitate the environment in the body for an implant. EIS measurements, polarisation curves and CVs showed a constant low Mg^{2+} dissolution (5 ng s^{-1} cm^{-2} ≈ 550 µg $month^{-1}$ cm^{-2} H_2 ≈ 14 mL $month^{-1}$ cm^{-2} H_2) for Magnesium composition ranges above 80 %. At lower concentrations of Magnesium, the dissolution increased significantly and peaks correlating to the applied potential could be observed. Zinc peaks sporadically appeared alongside these magnesium peaks while dysprosium dissolution remained below the detection limit. EIS showed strong inductive loops at high frequency for higher zinc contents supporting the stronger dissolution found in the ICP spectra.