ABSTRACT

Magnesium (Mg) alloys have received a wide attention as potential biomaterials because of their natural biodegradability, non-toxicity and excellent mechanical strength adjacent to that of the bone tissue. However, low corrosion resistance of the Mg alloys restricts their use in various industrial and biomedical applications. This work has been carried out with an aim to improve the electrochemical corrosion resistance of Mg-Al-Zn alloy by copper ions (Cu^+) irradiation in a Ringer Lactate solution. The samples of Mg alloy were irradiated by variable energy Cu^+ (0.8, 1.5, 2, 2.5, 3 and 3.5 MeV) using Pelletron Accelerator, while keeping ion dose constant at 5×10^{14} ions/cm^2. The ion range was calculated to be 0.7, 1.22, 1.57, 1.95, 2.44 and 2.79 μm for the samples irradiated at 0.8, 1.5, 2, 2.5, 3 and 3.5 MeV respectively. The surface morphology of the specimens was studied using scanning electron microscope (SEM). The SEM images showed defects composed of ejected material from the alloy surface that became more significant at 3.5 MeV. The energy dispersive x-ray spectroscopy validated the presence of copper ions inside the irradiated Mg-Al-Zn alloy. The structural analysis of pristine and Cu^+ irradiated samples was done through x-ray diffraction (XRD). The crystallite size of Mg alloy was decreased after Cu^+ irradiation. The Vickers hardness of the Mg alloy was abruptly increased at 0.8 MeV and then steadily increased with the further increase of ion energy. The electrochemical testing of the samples was conducted in a Ringer Lactate solution (6.0g NaCl, 6.1g $C_3H_5NaO_3$, 0.400g KCl, 0.27g $CaCl_2$) at 35°C by potentiodynamic polarization. The corrosion current density, corrosion rate and corrosion potential were calculated using EChem software. The results revealed anomalous changes in the corrosion rate of Mg-Al-Zn alloy with the increase of Cu^+ energy. However, the corrosion rate was considerably decreased to 0.1874 mpy at 3.5 MeV with respect to unirradiated specimen (38.49 mpy). The value of corrosion potential became less negative after copper ions irradiation. The analysis of the electrochemically corroded surface of pristine and copper ion irradiated specimens showed a decrease in surface pits after irradiation. This enhancement in corrosion resistance was attributed to the creation of copper oxide layer on the surface of sample as well as the diffusion of Cu ions inside the Mg-Al-Zn alloy due to which the oxidation/dissolution of specimen was reduced.