ABSTRACT

Polycrystalline Zirconium samples were irradiated by 1 MeV singly charged gold ions (Au^+) using Pelletron accelerator at doses of 1×10^{13}, 5×10^{13}, 1×10^{14}, 5×10^{14} and 1×10^{15} ions/cm^2. The purpose of the study was to improve the surface properties of zirconium especially for biomedical applications. The pristine and irradiated samples were characterized by x-ray diffractometer, field emission scanning electron microscope, hardness and electrochemical testers. The ions range inside the samples was calculated to be 142.2 nm by SRIM software. Structural study of the samples by Scherer and Williamson-Hall analyses displayed anomalous changes in the crystallinity of Zirconium with change of the ion dose. However, the preferred orientation of the Zirconium along (002) plane remained un-changed by the Au^+ irradiation. The field emission scanning electron microscopy showed irradiation induced defects such as bubbles, cavities, pits, craters, cracks and grain boundaries on the Zirconium surface. The Vickers hardness testing results also revealed anomalous changes in the hardness of the material following the classical Hall-Patch relation. The maximum increase in the hardness occurred in the sample irradiated with Au^+ of dose 1×10^{14} ions/cm^2. In order to perform electrochemical testing in Phosphate Buffer Saline (PBS) solution having pH 7.4, the Gammery potentiostat was used. Anodic and cathodic polarization curves were obtained by varying the potential and measuring the resultant current density. The results revealed a decrease in the corrosion rate and corrosion current density of the irradiated Zirconium. However, changes in these were observed to be anomalous with increase of the ion dose. The corrosion rate followed opposite trend as that of the crystallite size. The lowest corrosion rate was found for the sample irradiated at 5×10^{14} ions/cm^2.