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2nd International Conference on

Materials Science and Materials Chemistry

March 20-21, 2019 | London, UK

Study on mechanical properties and corrosion resistance of Mg-Zn-Nd alloys as potential biodegradable implants

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Mg alloys are considered as potential structural materials for biodegradable implants mainly due to their excellent biocompatibility, degradation behavior in in vivo conditions and adequate mechanical properties. However, their accelerated corrosion rate in physiological environments may lead to premature loss of mechanical integrity, gas embolism and cytotoxic effects.

Here we characterized the corrosion behavior and mechanical properties of a novel magnesium-zinc alloy, Mg-5%Zn-0.13%Y-0.35%Zr with up to 3% Nd additions following a homogenizing treatment and extrusion process, with regards to serving as a biodegradable implant. The microstructural characteristics were examined by optical microscopy, scanning electron microscopy (SEM), and X-ray diffraction analysis. The corrosion performance examination was carried out under in in vitro conditions, including immersion testing, electrochemical analysis, and stress corrosion cracking (SCC) assessments in terms of slow strain rate testing (SSRT), all in PBS solution. The mechanical evaluations included hardness and tensile examinations. The obtained results clearly demonstrated an optimal combination of strength and ductility for the new alloy at 2% Nd concentration. This was attributed to an optimal concentration of the secondary phase, W-phase ($Mg_3(Nd,Y)_2Zn_3$), generated at grain boundaries. The addition of different concentrations of Nd to the base alloy, resulted in minor effect on the corrosion resistance, nevertheless, the calculated corrosion resistance of all tested alloys was within the range which can be considered as suitable for biodegradable applications. Therefore it is believed that the new alloy at 2% Nd concentration, Mg-5Zn-2Nd-0.13Y-0.35Zr, can be considered as a potential candidate for biodegradable implants.

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