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Toward understanding the effects of solution heat treatment, Ag addition, and simultaneous Ag and Cu addition on the microstructure, mechanical properties, and corrosion behavior of the biodegradable Mg–2Zn alloy

Mohammad Asadollahi, Reza Alizadeh, Sayed Khatiboleslam Sadrnezhaad*

Department of Materials Science and Engineering, Sharif University of Technology, Tehran, Iran

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ABSTRACT

In this study, the effects of adding silver (0.2 and 0.6 wt%) and copper (0.1 wt%) antibacterial elements, on the microstructure, mechanical properties, and degradation behavior of the as-cast Mg–2Zn alloy were investigated. The obtained results indicate that both Ag and Cu showed significant grain refinement effects in the as-cast condition. The MgZn precipitates were formed in the as-cast Mg–2Zn–0.2Ag alloy, which contained a small amount of Ag. Increasing the Ag content to 0.6 wt% resulted in formation of the $Mg_{54}Ag_{17}$ phase. Simultaneous addition of 0.2 wt% Ag and 0.1 wt% Cu to the Mg–2Zn alloy caused the ternary Mg(Zn,Cu) precipitates to form. Solution-treated Mg–2Zn and Mg–2Zn–0.6Ag alloys had a single-phase microstructure, while some Mg(Zn,Cu) precipitates remained in the Mg–2Zn–0.2Ag–0.1Cu alloy after solution treatment. Shear punch test showed 15, 12, and 23% increases in ultimate shear strength values of the as-cast Mg–2Zn–0.2Ag, Mg–2Zn–0.6Ag, and Mg–2Zn–0.2Ag–0.1Cu alloys compared to the Mg–2Zn alloy, respectively. The hydrogen evolution rate of the as-cast Mg–2Zn–0.2Ag, Mg–2Zn–0.6Ag, and Mg–2Zn–0.2Ag–0.1Cu alloys were found to be 38, 90 and 70% higher than the as-cast Mg–2Zn alloy, respectively. However, the solution treatment reduced the degradation rate significantly. Hence, it was found in this investigation that adding Ag and Cu elements would be so effective for improving different properties of the Mg–Zn alloys by using appropriate solution heat treatment.

1. Introduction

In recent years, magnesium has been extensively introduced and used as a metal for degradable implants, which do not need secondary surgery to remove the implant after the tissue regeneration process. This development is mainly due to unique properties, such as biocompatibility, non-toxicity, an elastic modulus close to human bone, high specific

* Corresponding author.
E-mail address: r.alizadeh@sharif.edu (R. Alizadeh).
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