Response to Reviewer 1 Comments

**Point 1:** This is an interesting paper about the effect of Ga on Mg–5Sn alloy. However, the “corrosion part” should be corrected.

Line 104, (197) “the average corrosion rate (\( R \), mm/a)” What is a? period of time (year, month, day,⋯) ?

**Response 1:** Thank you for your advice. In the natural sciences, a is often used for “year”. It comes from the Latin “annus”, which means a year. However, this unit of corrosion rate is indeed not as common as “mm/y”, so we have replaced all the units of corrosion rate in the article with “mm/y”. The modification is highlighted in line 103, 232, Table 4 and Fig.6.

**Point 2:** Line 192 “The lowest corrosion current density and corrosion potential are 6.27×10^{-3} mA/cm²⋯” Due to the cathodic process control: “in the Tafel extrapolation method for measuring the Mg corrosion rate, the corrosion current density, \( i_{corr} \) (mA/cm²) is estimated by Tafel extrapolation of the cathodic branch of the polarisation curve⋯” [20]. Taking this into account, results of corrosion current density (based on figure 4) should be several times higher than results presented in table 4!

**Response 2:** Thank you for your correction. The original paper did not consider that the Tafel behavior of the anode branches of the investigated alloys polarization curves was very weak. The cathodic branch of the polarization curve has been re-fitted and the data are updated in Table 4. Modification for this are highlighted in line 102–103, 194.

**Table 4.** Fitting results of polarization curves of the Mg–5Sn–xGa alloys with varying Ga content in 3.5wt.% NaCl solution.

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Mg-5Sn</th>
<th>Mg-5Sn-0.5Ga</th>
<th>Mg-5Sn-1Ga</th>
<th>Mg-5Sn-2Ga</th>
<th>Mg-5Sn-3Ga</th>
</tr>
</thead>
<tbody>
<tr>
<td>( E_{corr} ) (V)</td>
<td>−1.596</td>
<td>−1.614</td>
<td>−1.658</td>
<td>−1.665</td>
<td>−1.684</td>
</tr>
<tr>
<td>( i_{corr} ) (mA/cm²)</td>
<td>9.73 × 10^{-2}</td>
<td>3.28 × 10^{-2}</td>
<td>3.82 × 10^{-2}</td>
<td>3.16 × 10^{-2}</td>
<td>2.79 × 10^{-2}</td>
</tr>
<tr>
<td>( R_i ) (mm/y)</td>
<td>2.223</td>
<td>0.770</td>
<td>0.873</td>
<td>0.722</td>
<td>0.638</td>
</tr>
</tbody>
</table>
**Point 3:** Line 201 “The cathodic branches of the polarization curves show that the cathodic current density decreases with increasing Ga content, demonstrating that Ga indeed retards cathodic reaction and thus reduces corrosion rate” so how to explain that cathodic Tafel slope is bigger in the absence of Ga?

**Response 3:** Thank you for your comments. The electrochemical method has the advantage of universal and effective determination of corrosion rate.

In this study, Tafel extrapolation method was used to fit the strongly polarized region of the cathode branch of the polarization curve of the investigated alloys. The fitting method is shown in Figure R1, in which Mg–5Sn and Mg–5Sn–3Ga alloys were used as examples. As can be seen from Figure R1, the larger the $\theta$ is, the higher the Tafel slope ($\beta_c$) is, and then the higher the fitting corrosion current density ($i_{corr}$) is. As can be seen from Figure 4, the cathode Tafel slope of polarization curve decreased after the addition of Ga indicating that the corrosion current density decreased, which was consistent with the experimental results of immersion experiments.

![Figure R1](image_url)

**Figure R1.** The schematic diagram of corrosion current density and corrosion potential was fitted by Tafel extrapolation.

**Point 4:** Polarization technique does not give reliable values for Mg alloys corrosion [4]. Polarisation curves can be useful to characterize of cathodic reaction, passive region or assessing the pitting corrosion potential. Unfortunately, anodic polarisation is too deep (fig 4) and does not allow to discuss about anodic reaction. Authors should correct this.
Response 4: Thank you for your advice. We have noticed that the original discussion on anode branch of polarization curve is not adequately presented by your comment, because the surface film on the Mg-based alloys is not stable enough to protect the matrix especially in highly aggressive solution. We have modified Figure 4 and supplemented the polarization curve test in solutions containing 0.1M (0.6 wt.%) Cl⁻ 0.01M (0.06 wt.%) Cl⁻. Additional experimental analysis has been highlighted in the line 206–221 of the paper.

Point 5: 3.5% NaCl is highly aggressive for magnesium alloys. In practice, concentration of chlorides in environment is much lower. The authors should present how addition of Ga improves resistance of passive layer (by anodic polarisation in solutions containing 1M Cl⁻, 0.1M Cl⁻, 0.01MCl⁻, 0.00.M Cl⁻...)

Response 5: Thank you for your comment. Following your comments, we have supplemented the polarization curve test in solutions containing 0.1 M (0.6 wt.%) Cl⁻ 0.01 M (0.06 wt.%) Cl⁻ . The experimental results are shown in the Figure 5 and R2 below. Since the NaCl solution with a concentration of 0.1M is still highly aggressive, we finally chose to use the electrochemical experimental data in 0.01 M NaCl solution to analyze the anode branch of the polarization curve. The following figure and analysis have been supplemented and highlighted in line 206–221.

The revised Figure 5a shows the representative anode branch of the polarization curves of the Mg–5Sn–xGa alloys in 0.01 M NaCl solution. In order to explore the influence of Ga element addition on anodic passive layer, the revised Figure 5b shows the changes in the passive current density ($i_{\text{passive}}$) values as a function of the Ga content. The $i_{\text{passive}}$ values were measured at the anodic potentials of -1.65 V. The average and standard deviation values were obtain from at least five measurements. Obviously, compared with the Mg–5Sn alloy, the $i_{\text{passive}}$ values of the other alloys decreased after adding Ga element, among which, the Mg–5Sn–0.5Ga alloy exhibited the lowest $i_{\text{passive}}$ value. The decrease of the $i_{\text{passive}}$ indicates the increase of the passive film stability. As mentioned above, Mg$_5$Ga$_2$ phase will be formed when Ga addition exceeds 0.5 wt.%, which belongs to the cathode phase and destroys the stability of passive film to some extent. Moreover, the passive film of magnesium alloy is extremely unstable and cannot protect the matrix, so the corrosion is mainly controlled by hydrogen evolution reaction of cathode.
**Figure 5.** (a) The representative anode branch of the polarization curves of the Mg–5Sn–xGa alloys in 0.01 M NaCl solution. (b) Passive current density ($i_{\text{passive}}$) values measured at -1.65 V based on (a). The average and standard deviation were obtained from at least 5 measurements.

**Figure R2.** (a) The representative anode branch of the polarization curves of the Mg–5Sn–xGa alloys in 0.1 M NaCl solution. (b) Passive current density ($i_{\text{passive}}$) values measured at -1.65 V based on (a). The average and standard deviation were obtained from at least 3 measurements.