

AFM and SEM Characterisation of the Microstructure of AA7075-T6

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High strength Al-Zn-Mg-Cu alloys (7xxx series) are susceptible to localized corrosion like pitting, intergranular and exfoliation corrosion. This susceptibility is due to the breakdown of the protective passive film on the alloy surface where potential differences between different phases are expected. Intermetallics are assumed to be nucleation sites for localized corrosion due to strong galvanic coupling with the matrix. Intermetallics in AA7075 have been investigated by several authors [1, 2] and it is well known that intermetallics containing Cu and Fe are cathodic with respect to the matrix and tend to promote dissolution of the matrix [3], but the difference in Volta potential between intermetallics and the matrix in AA7075 has not been measured yet. In order to understand the electrochemical behaviour of these particles, it is important to relate differences in composition to potential differences of intermetallics with respect to the matrix.

The material used to characterise intermetallics was AA7075-T6 polished up to 1 μm . The characterisation was performed by means of SEM (Jeol 840A) and AFM (Nanoscope III Digital Instruments). Using the AFM in the lift mode enabled to relate differences in Volta potential between intermetallics and the matrix to the composition of the intermetallics (Fig.1 and Fig.2).

Three types of intermetallics were observed in AA7075-T6 (Fig.1): $\text{Al}_7\text{Cu}_2\text{Fe}$, $(\text{Al,Cu})_6(\text{Fe,Cu})$ and Mg_2Si . $\text{Al}_7\text{Cu}_2\text{Fe}$ intermetallics had a size of 1-20 μm and were characterised by a higher Cu content than $(\text{Al,Cu})_6(\text{Fe,Cu})$ intermetallics. These intermetallics showed the highest difference in potential with respect to the matrix (Fig.3). $(\text{Al,Cu})_6(\text{Fe,Cu})$ intermetallics had a size of 1-20 μm and a lower Cu content compared to $\text{Al}_7\text{Cu}_2\text{Fe}$ intermetallics. These intermetallics were cathodic with respect to the matrix but showed a lower difference in potential than $\text{Al}_7\text{Cu}_2\text{Fe}$ intermetallics (Fig.4).

Mg_2Si intermetallics had a size of 1-10 μm . These intermetallics were anodic with respect to the matrix (Fig.5).

The difference in Volta potential between intermetallics and the matrix is related to the chemical composition of intermetallics.

In particular, the intermetallics with a high Cu content, $\text{Al}_7\text{Cu}_2\text{Fe}$, have a higher difference in Volta potential compared to intermetallics with a low Cu content, $(\text{Al,Cu})_6(\text{Fe,Cu})$. Therefore, it can be expected that these high-Cu intermetallics provide a stronger galvanic coupling with the matrix resulting in a more severe localized corrosion.

Refereces

- [1] R.Ayer, J.Y.Koo, J.W.Steeds, B.K.Park, Metallurgical Transactions A, 16A, 1925 (1985)
- [2] M.Gao, C.R.Feng, R.P.Wei, Metallurgical and Materials Transactions A, 29A, 1145 (1998)
- [3] R.P.Wei, C.M.Liao, M.Gao, Metallurgical and Materials Transactions A, 29A, 1153 (1998)

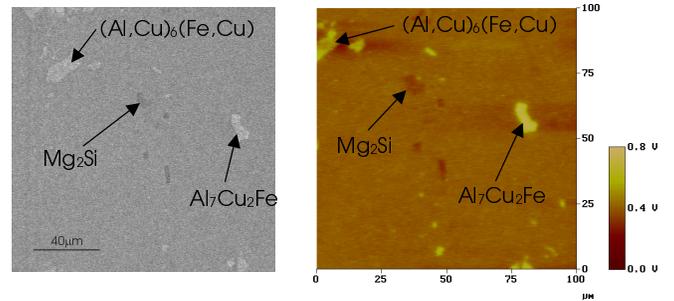


Fig. 1: SEM micrograph and AFM potential map of AA7075-T6.

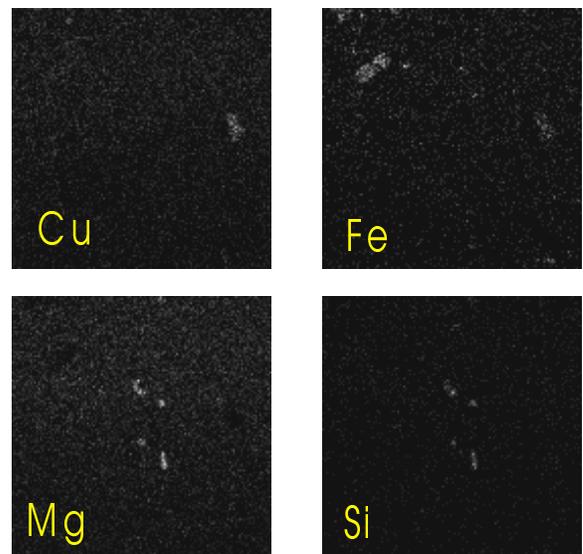


Fig. 2: EDS maps of AA7075-T6.

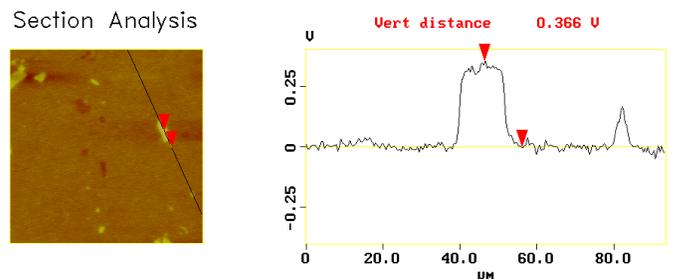


Fig. 3: AFM potential map for an $\text{Al}_7\text{Cu}_2\text{Fe}$ intermetallic.

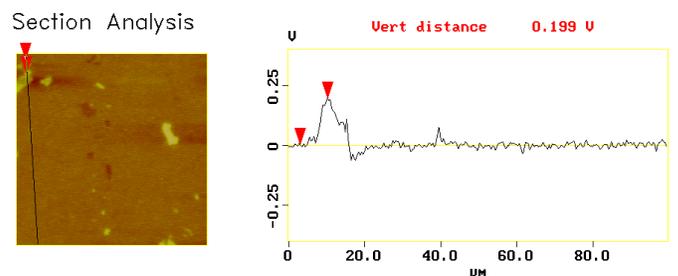


Fig. 4: AFM potential map for an $(\text{Al,Cu})_6(\text{Fe,Cu})$ intermetallic.

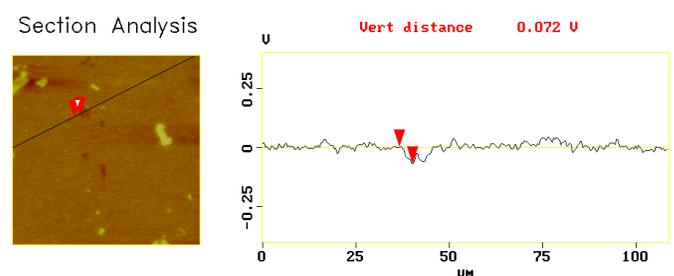


Fig. 5: AFM potential map for an Mg_2Si intermetallic.