Combined nuclear microprobe and TEM study of corrosion pit nucleation by s-phase inclusions in aluminium alloys

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Aluminium alloys for commercial applications (AA2024-T3 and AA7075-T6) contain numerous intermetallic inclusions comprising of one or more of the following elements: Al, Fe, Cu and Mn. These inclusions typically take on many shapes and have diameters up to 50µm on a rolled surface. Particle densities ranging from 3 x 10^5 to 1 x 10^{-6} per square centimetre have been measured. Exposed surfaces of these alloys require environmental protection against corrosion, which is usually accomplished by means of a conversion coating using Cr compounds with a further surface coating of an epoxy polyamide paint layer. The breakdown of these coatings allows the onset of corrosion in the aluminium alloy which is a significant problem given the wide application of aluminium alloys in infrastructure and transport (particularly aerospace). We have conducted a microscopic study of the onset of corrosion in these alloys with the aim of understanding the role of the inclusions in triggering the formation of deep pits in the corroding surface. By trace element mapping with a 3 MeV H^+ microprobe, we have shown that the s-phase particles have a high correlation with the pit nucleation and that the other phases play a less significant role. We have, for the first time, correlated the nuclear microprobe elemental maps with high resolution Transmission Electron Microscopy from the same regions to provide complementary elemental distributions that provide insight into the corrosion initiation.