Composition of Chromate Conversion Coatings Formed on Multi-layered Thin Films of AA2024-T3 Matrix and Analogs of Al2Cu, Al2CuMg, Al20Cu2(FeMn)3

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AA2024-T3 contains several alloying elements that lead to the formation of a complex, multiphase structure. Cu, Mg, Mn, Si, and Fe are present in appreciable amounts and form Intermetallic Compounds (IMC) of composition Al_2Cu, Al_2CuMg, Al_2Cu_2Fe, Al_7Cu_2Fe, $Al_{12}Si(FeMn)_3$, $Al_{20}Cu_2(MnFe)_3$, and $Al_{20}Cu_3Mn_3$. It is well known that there is a distribution of IMC compositions and morphologies in AA2024-T3 alloy surface [1-7]. Chromate Conversion Coatings (CCC) are use to inhibit this corrosion behavior. Previously, we have shown that the CCC is inhomogeneously distributed on the AA2024-T3 surface and that the underlying microstructure induce spatial and depth composition heterogeneity in the CCC [1,3,7]. Recent investigations have also considered some of the effects of aging on CCC composition and morphology for an alloy such as AA2024-T3 [5,8-10,12-13]. Previously [13] we have shown by Extended X-ray Absorption Fine Structure (EXAFS) that the structure of the CCC formed on the alloy and individual IMCs has a structure similar to Cr mixed oxide compound proposed by McCreery et al. [14] and that it changes to a higher ordered CCC during 20 hours of aging. These studies were done on individual thin film analogs. However, the poor corrosion behavior of the alloy is due to the galvanic currents generated between the AA2024-T3 matrix and the IMCs. Therefore, in order to completely understand the CCC formation process, it is essential to assess the behavior of individual IMC when coupled to the matrix.

This study addresses the influence of the galvanic currents between the matrix and IMCs on the structure and composition of CCC formed on individual constituents particles. In order to observe the influence of galvanic currents between the matrix and intermetallic particles, large areas of structurally and compositionally accurate multi-layered thin films analogues of the AA2024-T3 matrix and several intermetallic compounds found on AA2024-T3 such as Al_2Cu, Al_2CuMg, Al_2Cu_2Fe, Al_7Cu_2Fe, $Al_{12}Si(FeMn)_3$, $Al_{20}Cu_2(MnFe)_3$, and $Al_{20}Cu_3Mn_3$ have been created and chromate conversion coated. The composition of the matrix was obtained using Energy Dispersive Analysis of X-rays on areas of an AA2024-T3 sample where no particles were present. The multi-layered thin film samples were created using the two-step process described on previous work [7] i.e. using Reactive Arc Melted coins as targets for femtosecond laser ablation. Structure and surface chemical data was developed using several structural and surface sensitive techniques including Synchrotron Infra-Red Microspectroscopy (SIRMS), Secondary Ion Mass Spectroscopy (SIMS), X-ray Photoelectron Spectroscopy (XPS), EXAFS and X-ray Absorption Near-Edge Structure (XANES). This data was used to refine an existing model for CCC formed on Al-Cu alloys (11).

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