

Cranfield University

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**Evaluation of Aluminium–Based Coatings for
Cadmium Replacement**

School of Industrial and Manufacturing Science

PhD Thesis

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Academic Year 2003/04

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December 2003

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ABSTRACT

Cadmium electroplating is widely used in the aerospace industry for the corrosion protection of aircraft components like fasteners manufactured from non corrosion resisting high strength steels. However, environmental and safety concerns over the high toxicity of cadmium and its compounds have led to the investigation of suitable replacements. Alternatives to cadmium should offer effective corrosion protection and have no detrimental effects on the steel substrate. Hydrogen is known to be absorbed during processes like electroplating, thus causing hydrogen embrittlement on high strength steel fasteners. Another source of hydrogen is the water reduction occurring in parallel with the corrosion of the coating, and thus causing re-embrittlement of the steel substrate. This study has investigated the effect of the application of two aluminium-based coatings, SermeTel CR984-LT and Galvano-Aluminium Alcotec, on the hydrogen re-embrittlement of high strength steels used for aerospace applications.

Slow strain rate testing has been performed to study the effect of hydrogen on the re-embrittlement of the steel substrate as a result of the corrosion of the aluminium-based coatings in a variety of environments, such as NaCl solution, salt spray and marine atmosphere. Permeation measurements have been used to measure hydrogen uptake by unplated steel membranes potentiostatically charged at the potentials of the aluminium-based coatings, so as to simulate the amount of absorbed hydrogen due to their corrosion. Corrosion tests have been utilised to evaluate the performance of SermeTel CR984-LT and Galvano-Aluminium Alcotec.