Corrosion protection of dissimilar materials.

Developing novel coatings for improved corrosion performance of fasteners for dissimilar material joining applications.

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Introduction

In a range of industrial sectors, multi-material constructions are used to optimise the performance of structures. In the transport sector, metal-to-carbon fibre reinforced polymers (CFRP) and steel-to-aluminium joints are seeing dramatic growth in both R&D activity and commercial applications. As these materials are not weldable directly, industrial joining solutions involve the use of mechanical fastening and adhesives. These dissimilar material combinations are highly susceptible to corrosion, as a result of galvanic coupling between parent materials with greatly differing electrode potentials. Despite the widespread use of fasteners to create these dissimilar joints, very little development of fastener coatings to mitigate corrosion has been performed. In the automotive sector, only 2 strategies are used for dissimilar metal and metal-to-composite joints, namely:

1. Carbon steel fastener + zinc coating

2. Austenitic stainless steel fastener without coating

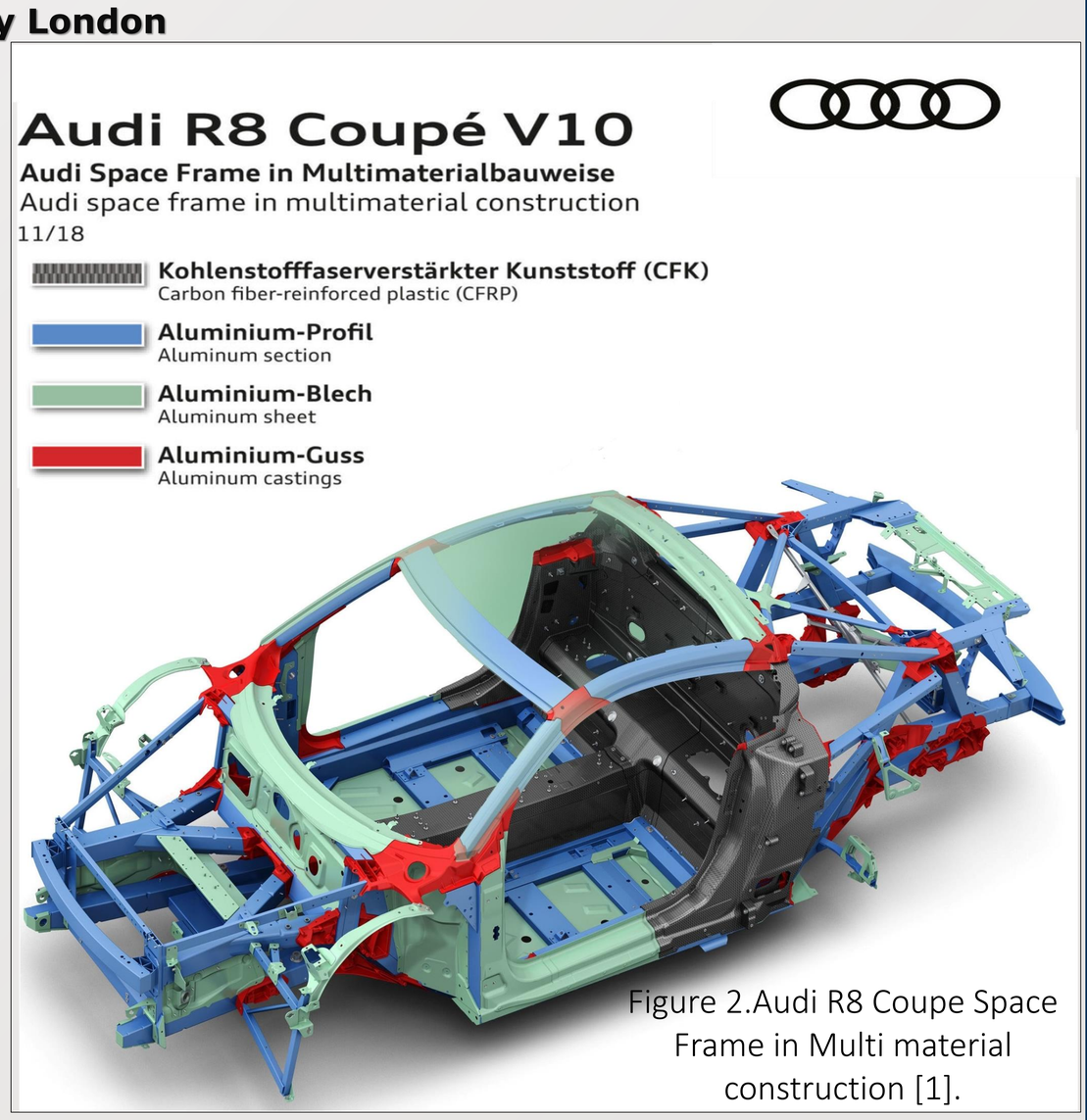

Figure 2.Audi R8 Coupe Space Frame in Multi material construction [1].

Research question

For automotive applications, very little long term corrosion data for mechanically fastened dissimilar joints is available in literature and studies to optimise fastener materials and coatings have not been performed for metal-to-composite joints. Nevertheless, there are widespread concerns regarding the long term durability of dissimilar joints. In production cars, dissimilar joints are used almost entirely in 'dry' areas of vehicles, where exposure to water, salt and stone chipping from road surfaces does not occur, theoretically. In order to further reduce the risk of corrosion-induced failure, dissimilar mechanical joints in cars are coated with sealants, zinc-phosphate crystals and multiple layers of paint and lacquer. These measures are taken because present data show that, if paint layers are penetrated and dissimilar joints are exposed to electrolytes, rapid deterioration of the fastener and joint occurs. If the corrosion issue can be solved, it would mean optimal selection of multi materials solutions in the entire vehicle, which would have a much greater impact on weight savings and therefore CO_2 reduction than the current situation.

Figure 1. Zinc-coated carbon steel rivet in aluminium to CFRP joint, exposed to 96 hours of salt spray, total rivet failure occurred.

To experimentally determine the mechanical and corrosion performance of suitable commercially available coatings in fastener applications

Aims and Objectives

To produce a predictive model of corrosion performance based upon analytical electrode potential measurements.

To generate data indicating optimum combinations of coated fasteners with dissimilar materials to minimise corrosion.

How to achieve it

Evaluate in long-term atmospheric exposure and accelerated salt spray conditions.

Electrochemical characterization of base materials

Electrochemical characterization of coating performance

References:

1. https://www.audi-mediacenter.com/en/the-new-audi-r8-updated-dynamics-for-the-high-performance-sports-car-11734/audi-space-frame-asf-11741