Titanium Bonds: A Study on the Efficacy of Varied Surface Preparation Methods of Titanium Substrates for Optimised Structural Adhesion

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This investigation focuses on varied surface preparation methods of titanium substrates for optimised structural adhesive bonding. In aircrafts, adhesives must provide sufficient support in bonding together composite or metal parts for the structure to establish a safe, secure environment. According to Boeing statistics, 20% of aircraft disasters are a result of fatigue and material failures (Boeing, 2019). Additionally, in 2017, the Marine Corps KC-130 aircraft crashed as a result of structural and material failure (Insinna & Ziezulewicz, 2022). In exploring the causative relationship between surface preparation and adhesives, this inquiry seeks to mitigate the effects of inadequate material bonding through optimisation by surface preparation; what is important is ensuring the safety of the pilot and the aircraft when bonding critical components. Without a mode of surface preparation prior to adhesive bonding, structures are likely to fail due to external stresses placed upon the material, causing fatigue, cohesive, and adhesive failure. The methods of surface preparation methods of titanium being evaluated in this experiment include basic scouring with an abrasive mat (Scotch Brite), abrasive aluminium oxide grit blasting, manual abrasion with a stearated and non-stearated sanding disc, and plasma treatment. This raises the research question: What method of preparation will introduce the greatest amount of surface energy between titanium alloy substrates and epoxy-film adhesive? It is hypothesised that if different sets of titanium alloy lap shear surfaces are prepared using different surface preparation techniques, the plasma treated metal-adhesive bond will withstand the maximum load stress in tensile testing, and was supported by the results.