Effect of Alternative Paint Stripping Processes on the fatigue performance of Aluminium Alloys - Atmospheric Plasma De-painting

Ali Merati and Marko Yanishevsky
Aerospace Research Centre
National Research Council Canada

Typically aircraft paint schemes lose their effectiveness for corrosion protection as well as cosmetic appearance every three to five years. As such, an aircraft will typically undergo at least five paint / de-paint cycles in its lifetime. The conventional methods for removing paint employed throughout the Canadian Forces mainly include environmentally unfriendly chemical stripping and abrasive media blasting. These processes yield high amounts of volatile organic compounds and generate large quantities of waste which requires proper disposal / treatment. Concern over environmental, safety and worker health with current paint removal processes has resulted in the enactment of new alternative removal processes during the past several years.

Atmospheric Plasma (AP) has the potential to replace conventional paint stripping methods used for military aircraft structures in the Canadian Forces. As part of a Department of National Defence green initiative for aircraft repair and maintenance, NRC had been tasked to investigate the potential of this novel technology.

In this study, the effectiveness of the novel APS system was compared to the chemical solution and Type VII starch-acrylic media blasting stripping processes. The effectiveness was assessed mainly by four criteria: i) extent of paint removal, ii) extent of deformation, iii) effect on crack detectability during Liquid Penetrant Inspection, and iv) effect on temper and fatigue properties. The latter will be elaborated in this paper. The objective here was to determine whether paint stripping using Atmospheric Plasma was beneficial, detrimental or neutral with respect to the fatigue properties of aluminium substrates.

Aluminium 2024-T3 and 7075-T6 in both large panels (with 78 holes with EDM notches) as well as simple fatigue coupons were studied to investigate the effect of de-painting process on crack nucleation and crack growth rate. The panels were then cyclically loaded in a load frame to generate visible cracks on the surface of the aluminium panels. The fatigue behaviour on both the paint-stripped and unstripped sample/region were measured and compared. Fatigue testing and crack length measurements revealed that the AP paint stripping process, similar to the traditional processes, was neither detrimental nor beneficial to the fatigue properties of the aluminium substrates. The graphs in Figure 1 compare each crack on the stripped region to its mirrored crack in the unstripped region seen in Figure 2.

The crack lengths for both regions appear to be very similar, illustrating the AP stripping process did not appear to negatively affect the behaviour of the crack growth as the crack lengths were consistent in both the paint stripped and unstripped regions. In all cases, regardless of paint colour, substrate thickness or aluminium alloy, the averages of the crack lengths in the paint stripped regions were approximately equivalent to the lengths in the unstripped regions. The results of recent NRC studies are encouraging for the Atmospheric Plasma coating removal process and support further development for the technology's emergence into industrial applications.

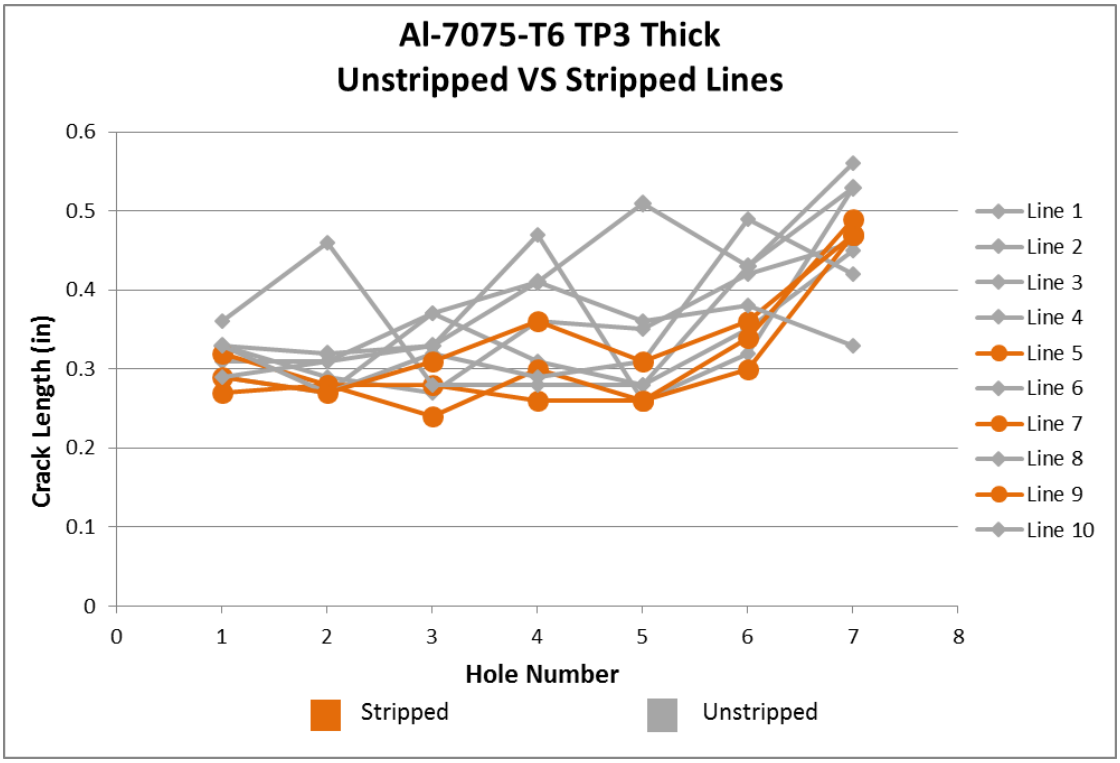

Figure 1: Al-7075-T6 TP3 full crack length results and comparison between all lines on the test panel.

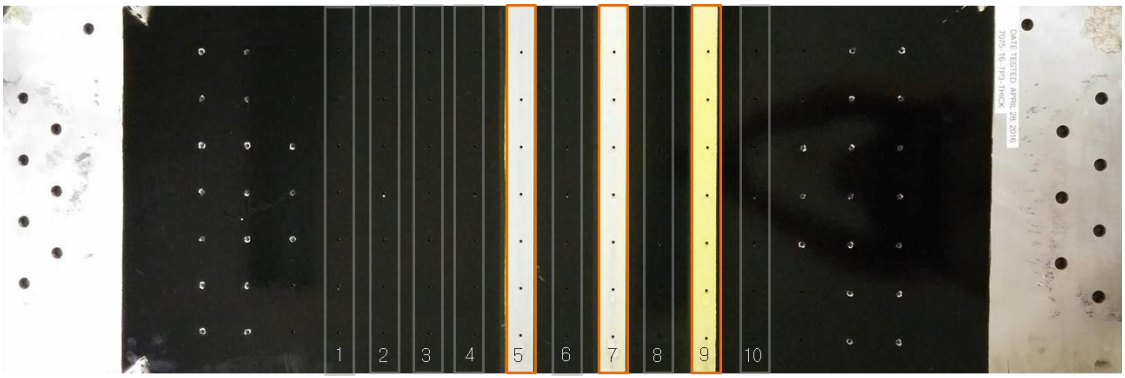

Figure 2: Panel layout showing stripped and non-stripped lines in Figure 1.

Keywords: atmospheric plasma, paint stripping, fatigue performance, aluminium substrate