Comparison of environmentally assisted cracking in high zinc content 7xxx Al alloys imaged by of time-lapse synchrotron computed tomography (CT)

Tim BURNETT[1], Visweswara GUDLA[1], Zak BARRETT[2], Al GARNER[1], Henry HOLROYD[3], Christian ENGEL[4], Phil PRANGNELL[1], Malte STORM[5], John LEWANDOWSKI[6], Ben PALMER[6], Philip WITHERS[1]

[1] The University of Manchester, United Kingdom
[2] Airbus, United Kingdom
[3] The Univeristy of Manchester, United Kingdom
[4] Airbus, Germany
[5] Diamond Light Source, United Kingdom
[6] Case Western Reserve University, United States of America

Owing to their high strength capability, 7000 series Aluminium (Al) Zinc (Zn) magnesium (Mg) Copper (Cu) alloys have been the subject of considerable interest and development since their first widespread application in commercial aircraft in the 1950s. Issues with Stress Corrosion Cracking (SCC) were reported early on in their history and considerable development work has since been undertaken to combat this limitation, through the optimisation of compositions and heat treatments, which culminated in the registration of higher Cu containing alloys such as AA7050 and AA7010 in the early 1970s. When deployed in an overaged condition (e.g. T7651, T7451) these materials have good stress corrosion performance and have subsequently exhibited few problems in service.

In this paper we present investigations using high resolution time-lapse synchrotron computed tomography (CT) imaging to investigate the crack development behaviour of environmentally assisted cracks (EAC) in some of the latest generation high zinc containing alloys. In this case the later generation AA7085is compared to the previous generation AA7050 material. We prepared round bar tensile specimens from the T/2 position of thick plates of these two materials in the T7651 temper before subjecting them to slow strain rate testing in humid air. The synchrotron CT imaging has provided high resolution (~3 µm) images of crack development with respect to time over a ~4 mm length section of the 3.2 mm diameter gauge.

We have been able to concurrently track multiple EAC cracks that emerge from a size of around 20-30 µm and quantify their size, location and shape as they grow until the final failure of the specimen is reached. We are now working to identify regions of interest for site-specific post mortem examination to understand the local microstructure surrounding these features with increased resolution; the ultimate aim being to determine if a correlation between local microstructure and crack path exists. In addition we are also creating a picture of how the macroscale performance is built up from the microscale behaviour of the individual cracks. It is clear there is an abundance of new information in this data. At present we face a significant big-data challenge to process and quantify several hundred 3D images extending to nearly 20 TB of data. We are also proceeding to automate more of the data analysis and this work is being conducted in parallel.