

Understanding the Role of the Carbon Dioxide System in
Corrosion of Aircraft Lap Splice Joints
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As the fleet of both commercial and military aircraft ages, corrosion becomes a more important concern. Areas that are occluded are of particular interest because of the difficulty associated with detection and measurement of corrosion within these regions. One example of an occluded region is the lap-splice joint. Lap-splice joints are an area on the fuselage of an aircraft where two sheets of aircraft skin overlap and are riveted together. Prior work has studied the lap-splice joint environment and has led to the development of a model solution for laboratory testing. This solution contains 20 mM chloride, 4 mM bicarbonate, 4 mM nitrite, and 2 mM fluoride at pH 9. Each of these ions affects a different corrosion or electrochemical parameter. Bicarbonate is of particular interest because it affects not only the open circuit potential, but also the formation of the corrosion topography. The next step in this work is to determine the mechanism by which bicarbonate influences the corrosion of AA2024-T3.

Initial experiments involved the use of mock-up lap joints constructed from two pieces of AA2024-T3 sheet held together using aluminum (AA5052) pop rivets. They were placed in the exposure containers so that the solution would enter the joints by capillary action. The mock-up joints were exposed for three months to the model solution without alteration and with minimized carbon dioxide and bicarbonate (the CO_x system). In order to minimize the CO_x , the bicarbonate was omitted from the model solution and the solution was deaerated prior to exposure. The exposure container was placed within a dessicator over sodium hydroxide in vacuum. Sodium hydroxide was used because of its ability to absorb CO_2 . After the exposure, the mock-up joints were examined using cross-sectional microscopy as shown in Figure 1. The mock-up joint exposed to the ambient environment had a corrosion topography that was general. General corrosion is the most common corrosion topography found in aircraft lap-splice joints. The mock-up in the low CO_x environment, however, had pitting as the dominant topography. This experiment indicated that within a three month time span the presence or absence of the CO_x system determined the corrosion topography.

Current experiments are using confocal laser scanning microscopy (CLSM) to monitor the formation of the corrosion topography with various exposure solutions. Confocal microscopy allows for the construction of 3-D images of the sample surface. The development of corrosion topography has been observed over three months and found to begin with small pits which are dominated by general corrosion after four weeks of exposure. The images obtained from confocal microscopy will be analyzed using image analysis software. From this, parameters will be determined that will differentiate general and pitting corrosion.

Future work will investigate the buffering capacity of CO_x and the effect it has on corrosion formation. We will also study the effects of CO_x on various electrochemical parameters. These studies will provide a fundamental basis for a recommendation on the

use of bicarbonate based cleaning systems for aging aircraft.

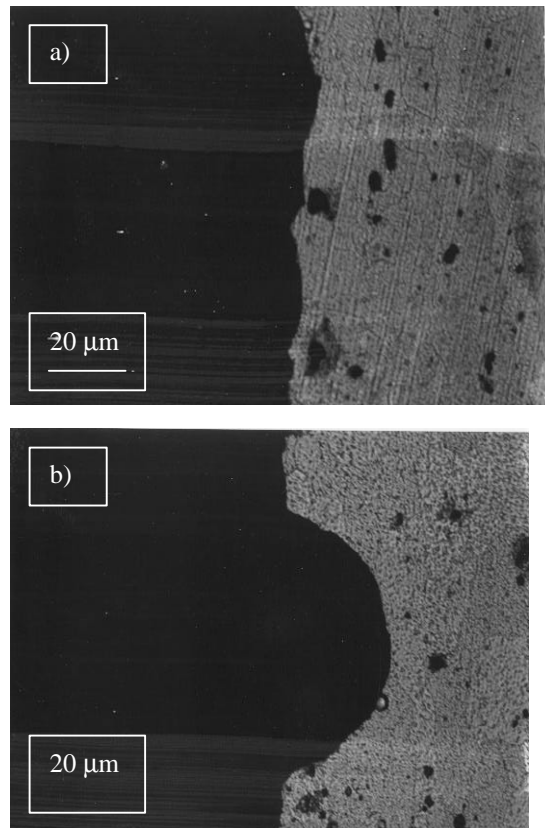


Figure 1: Corrosion topography formed after 3 month exposure to a) model solution and b) model solution without CO_x at 500x magnification

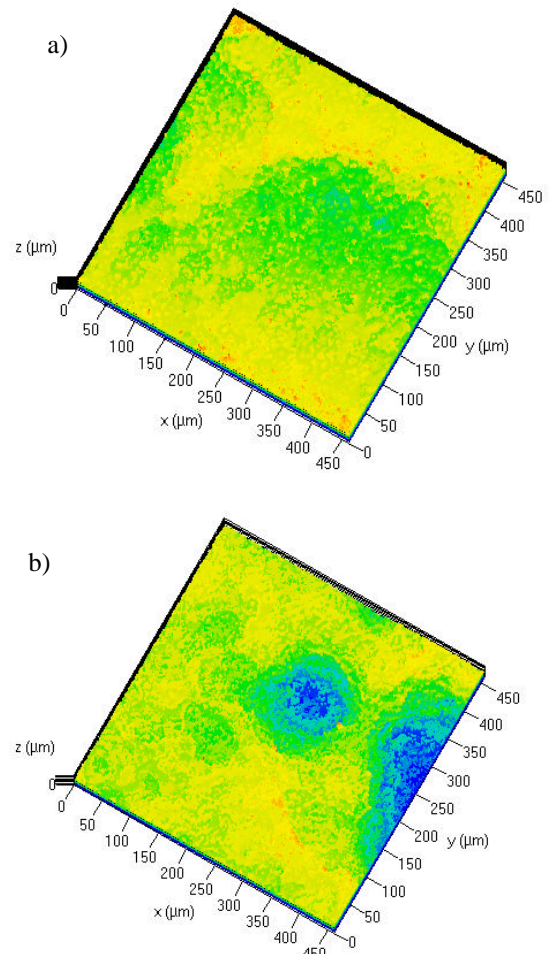


Figure 2: Confocal images of model lap joint exposed to a) simulant solution and b) simulant solution with minimal carbon dioxide for 90 days