Effect of Carbon Deposits on the Corrosion Behavior of 2214 T6 Aluminum Alloy

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Anodized aluminum alloys are widely used in aircraft industry for various structural parts. Sealed anodic films on these alloys are often used for durable appearance, protection against corrosion or adhesive bonding. However, anodic films can lose their protective properties when defects are created and the alloy degradation may be accelerated in presence of more noble elements such as carbon. It can be the case in the aircraft braking equipments for some parts such as the anodised aluminum wheels. During aircraft braking, the carbon constituting the disk brakes is powdered and flung on the wheels where it forms deposits. The temperature of the pulverised carbon can be up to 1000°C and the wheels can locally reach 200°C. Can the carbon, in presence of an aggressive media, constitute an accelerating factor of the corrosion of the anodized aluminum ?

The samples prepared from wrought aluminum alloys 2214 T6 (Cu 4.45%, Si 0.85%, Mn 0.80%, Mg 0.50%, Fe 0.30%, Zn 0.25%, Cr 0.10%) were anodized in a 20% sulfuric acid solution at a constant cell voltage of 14-22 V during 25 min at room temperature and sealed in a 5.5 $g.l^{-1}$ Ni and Co acetate-containing bath for 20 min. at 97°C. Artificial and reproducible cracks were obtained using a diamond-tipped durometer charged with 3 N. Carbon powder with a 0-40 µm granulometry was deposited at the surface.

To evaluate the corrosion behavior of the anodic layers, impedance measurements were carried out in 0.1 M NaCl. Observations of the surface were performed using optical microscopy.

When the surface does not present any defects, impedance diagrams (Fig. 1) are the same for specimens with or without carbon deposits on the surface. So, carbon seems to have no influence on the degradation of the layers.

Figure 2 shows the anodised surfaces with and without carbon for scratched samples after 4 days of exposure in 0.1 M NaCl. The sample without carbon does not appear to be corroded. On the contrary, the sample with carbon deposit is hardly corroded near the scratches. Thus, carbon appears to have an accelerating effect on the degradation of anodized samples only in the case where carbon is connected to the aluminum matrix. Defects which allow carbon/metal contact is thus necessary to create a galvanic attack.

Such defects on the anodized aluminum alloys can appear when the wheels are heated at moderated temperature. Figure 3 shows, for instance, cracks developed in the anodization layer for a sample maintained for 40 minutes at a temperature as low as 80°C. In presence of pulverized carbon flung on the wheels an accelerated degradation of the aluminum alloys can then occur.

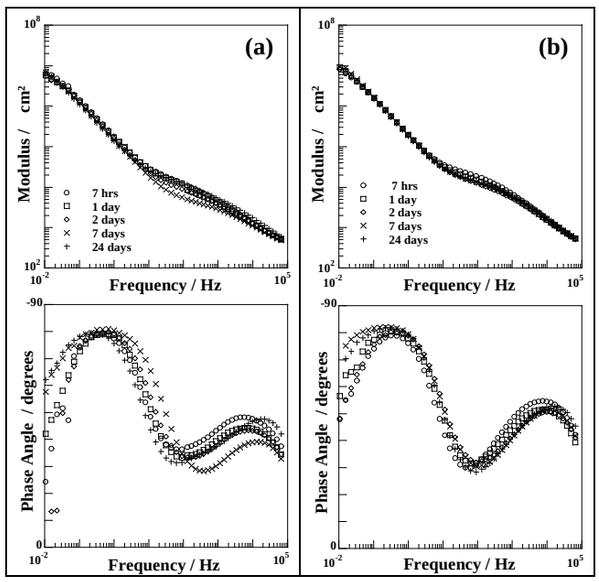

Figure 1 : Impedance diagrams as a function of immersion time in 0.1 M NaCl for 2214 alloy anodized in sulfuric acid bath and sealed in a Ni and Co acetate solution - (a) without and (b) with carbon deposits.

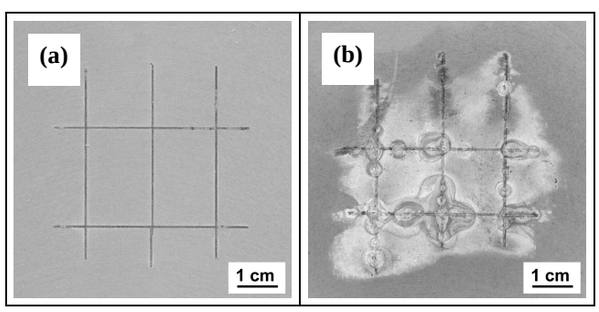

Figure 2 : Surface of scratched specimens after 4 days of immersion in 0.1 M NaCl - (a) without and (b) with carbon deposits.

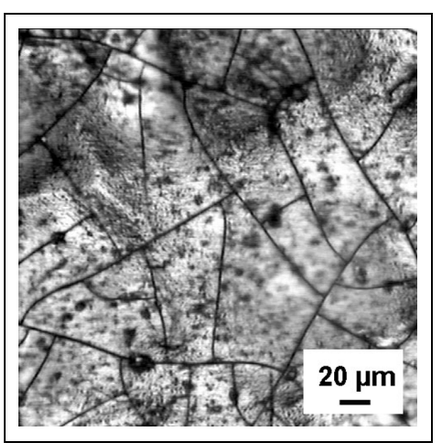

Figure 3 : Cracked surface of an anodized 2214 aluminum sample maintained at 80°C for 40 min.