

Inhibition of the pitting corrosion of 2024 aluminum alloy by 1, 2, 3-benzotriazole

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The corrosion behavior of aluminum alloys is largely influenced by the microstructure and particularly by the shape, size and chemical composition of the intermetallic particles. In previous works (1-2), the resistance to pitting corrosion of 2024 aluminum alloy in chloride-containing sulfate solutions was related to the reactivity of Cu and Mg-rich particles (S-phase particles). These intermetallics were dissolved during the polarization stage in sulfate solution and, for low applied potentials, copper was deposited on and around the particles. Micropits formed on these copper deposits due to the aggressivity of sulfates towards copper. On addition of chloride ions, there was a synergy between chloride and sulfate ions and pits very rapidly formed on these copper deposits. At high potentials, copper could not be redeposited and pits formed in the matrix.

Since 1, 2, 3-benzotriazole (BTAH) is well-known for its inhibitory action on copper dissolution (3), experiments were performed to evaluate its efficiency on the pitting corrosion of 2024 alloy in chloride-containing sulfate solutions.

Figure 1 shows the potentiokinetic curves plotted for 2024 alloy in a 0.004M NaCl + 0.1M Na₂SO₄ solution with or without BTAH (0.01M). BTAH was shown to influence both cathodic and anodic reactions. In the anodic domain, BTAH allows a wider passivity plateau to be obtained and the pitting potential to be shifted from -400 mV/SCE to -150 mV/SCE.

Statistical analysis of the pitting behavior was also performed. Figure 2 shows the pit nucleation rate versus potential for samples polarized in sulfate medium with or without BTAH. Without inhibitor, a strong peak of susceptibility to pit nucleation was observed at low potentials due to the synergy between chloride and sulfate ions towards copper deposits. When BTAH was added, the maximum of pit nucleation rate was strongly decreased, from 420 s⁻¹.cm⁻² to 140 s⁻¹.cm⁻².

The results thus showed that BTAH protected very efficiently 2024 Al alloy towards pitting corrosion at low potentials. Scanning Electron Microscopy (SEM) observations (fig. 3) showed that, in the presence of BTAH, S-phase particles were protected. When BTAH was not present in solution, a copper enrichment was observed for the S-phase particles. Before polarization, EDS analyses allowed a copper content of 40 wt% to be evaluated while, after polarization in chloride-containing sulfate solutions, the copper content increased until 70 wt%. With BTAH, no copper enrichment was observed. The mechanism of inhibition of 2024 pitting corrosion by BTAH was thus related to the action of BTAH on S-phase particles due to their high copper content. On the contrary, BTAH was not an efficient inhibitor for 2024 alloy at high potentials (fig. 2). In fact, in the presence of BTAH, pits formed in the matrix whatever the potential. This was checked by plotting the pit propagation rate versus potential. Without BTAH, two linear segments

were observed, one at low potentials related to the propagation of pits on the copper deposits and the other one at high potentials for the propagation of pits in the matrix. In the presence of BTAH, only one straight line was observed with a slope similar to that observed at high potentials without BTAH.

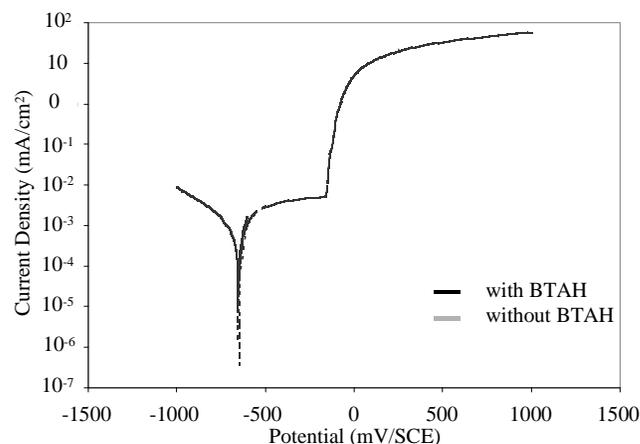


Figure 1: Potentiokinetic curves for 2024 Al alloy in chloride-containing sulfate solutions with and without BTAH

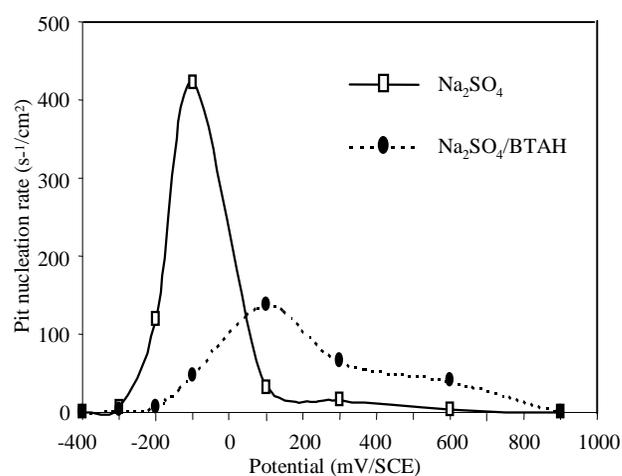


Figure 2: Pit nucleation rate versus potential for 2024 Al alloy.

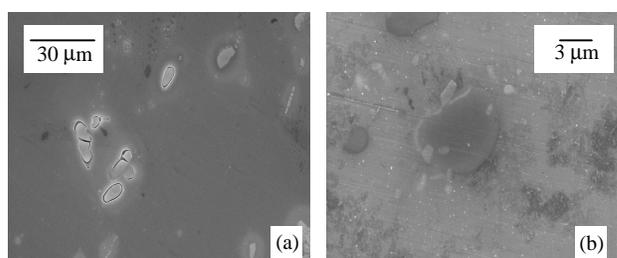


Figure 3: S-phase particles after polarisation at -200 mV/SCE in chloride-containing sulfate solutions (a) without BTAH (b) with BTAH

References :

1. C. Blanc, B. Lavelle and G. Mankowski, *Corros. Sci.*, **39**, 495 (1997)
2. C. Blanc and G. Mankowski, *Corros. Sci.*, **40**, 411 (1998)
3. W. Qafsaoui, Ch. Blanc, N. Pébère, A. Srhiri and G. Mankowski, *J. Appl. Electrochem.*, **30**, 959 (2000)