Corrosion Behavior of Al 6082 T6 Hard Anodized Aluminum Alloy Specimens in Deep-Sea Environment

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Al 6082 T6 hard anodized aluminum alloy specimens were exposed in deep sea, at a depth of approximately 3,350 m, off the Capo Passero (Sicily, Italy) in the KM3NeT project framework. All specimens—as retrieved from the sea after 6, 12, and 18 months of exposure—showed visible corrosion products on the thin lateral faces and on the edges, while the tops and bottoms of the samples remained nearly uncorroded. This confined hard anodization failure was ascribed to surface inhomogeneity that determined a reduction of corrosion protection.

INTRODUCTION

The interest in resource exploitation of the deep sea is continuously increasing. Despite this, field studies about corrosion of materials in the deep-sea environment are quite uncommon in the available literature (Traverso and Canepa, 2014) due to technical challenges and experimental cost. To the authors’ knowledge, solely Reinhart (1976) has exposed specimens of anodized aluminum alloys (Al 2024 T3, Al 2024 T81, Al 7002 T6) in the deep sea. This work shortly describes the results of the deep-sea immersion of Al 6082 T6 hard anodized aluminum alloy specimens in the frame of the Cubic Kilometre Neutrino Telescope (KM3NeT) project (http://www.km3net.org/; accessed March 23, 2016).

EXPERIMENTAL SETUP

Specimens were exposed for 6, 12, and 18 months off the Capo Passero (Sicily, Italy), at the NEutrino Mediterranean Observatory (NEMO) site (Meccia et al., 2015), at a depth of approximately 3,350 m, at approximately 55 m from the sea bottom. They were installed on three specially designed cylindrical anodized aluminum cages deployed with the help of three mooring lines (experimental design is described in more detail in Traverso and Canepa (2014)). Chemical composition (in weight percentage) of the Al 6082 T6 alloy was 0.7%–1.3% Si, 0.50% Fe, 0.10% Cu, 0.40%–1.0% Mn, 0.6%–1.2% Mg, 0.25% Cr, 0.20% Zn, 0.10% Ti, and the rest is Al. The size of the specimens was 100 mm × 100 mm, with 3 mm thickness. Specimens were sulfuric acid anodized after cutting and drilling (Type III, 50 μm nominal thickness).

RESULTS

All specimens, as retrieved from the sea after 6, 12, and 18 months of exposure, showed visible corrosion products on the 3 mm high lateral faces, on the edges, and near the four corners, where 6 mm diameter holes were drilled to place anchorage plastic bands. As an example, an alloy specimen retrieved from the sea after 6 months of exposure is displayed in Fig. 1. It clearly shows the severe corrosion attack at the lateral faces, edges, and holes with respect to the very limited one at the top and bottom surfaces.

Specimens retrieved after 6, 12, and 18 months did not show relevant visual differences. Weight loss (mg cm⁻²) as a function of the immersion time was 3.03 ± 0.01, 3.04 ± 0.01, and 3.06 ± 0.01, after 6, 12, and 18 months, respectively.

To understand the reasons for the hard anodization failure on the lateral faces, the surfaces of a nonsubmerged specimen were