Corrosion Studies at the Interface between Ceramics and 6061-T6 Aluminum

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The objective of this research was to study the corrosion of 6061-T6 aluminum coupled to different types of ceramics. Outdoor exposure tests, humidity chamber and immersion tests and zero-resistance ammeter tests were conducted using the couples. Ceramic/metal armor systems are used as land vehicle armor systems, personal armors, helicopter armor, and armor tiles for land vehicles. Ceramics tested in this research were titanium diboride, silicon carbide, boron carbide, silicon nitride, and aluminum nitride. The 6061-T6 aluminum is a popular backing material on the basis of low density and low cost. Aluminum backing material can save up to 37% of the weight as they reduce the areal density when compared with steel armor of same ballistic efficiency.

A holder was designed to couple the 6061-T6 aluminum to the ceramic tile. The couple holder was made of 6061-T6 aluminum to minimize contamination of the electrolytes with constituents other than that of the 6061-T6 aluminum backing material. The 6061-T6 aluminum bolts were used to couple the ceramic tiles and 6061-T6 aluminum coupons. A jig was designed to hold the ceramic tile and 6061-T6 aluminum coupon during assembly.

These couples were deployed in two test sites described as wet and marine test sites. Weight loss data was observed after 90 days and corrosion rate was determined. Fig 1 shows the couple deployed at Coconut Island (marine test site). Table 1 shows the comparison of corrosion rate in gmd at the interface after 90 day exposure.

Humidity chamber and immersion studies were also conducted. The couples were treated with electrolytes for one minute and kept inside a humidity chamber at 30^o C and 90% relative humidity for 90 days. The electrolytes used were 3.15 wt% NaCl, 0.5M Na_2SO_4, ASTM seawater, real seawater and 18.1 MΩ-cm water.

The couples were immersed inside the above mentioned electrolytes and kept inside a temperature bath at 30^o C. Weight loss data will be observed after 90 days and corrosion rate will be determined for the humidity chamber and immersion experiments.

The zero resistance ammeter technique was conducted using 6061-T6 aluminum and TiB_2 electrode to measure the galvanic corrosion rate in aerated conditions at 30^o C in the above mentioned electrolytes.

Corrosion rates of B_4C/6061- T6 aluminum couple were recorded high in both the test sites after 90 days. In electrochemical studies of the TiB_2 coupled to 6061- T6 aluminum in the aerated condition, the highest i_{Galv} was observed in the case of 3.15 wt% NaCl and lowest was in real seawater.

Determining galvanic corrosion rate in the de-aerated condition using the same technique and electrolyte is planned for the future and the feasibility of doing the same using less conductive ceramics like B_4C and SiC is underway.

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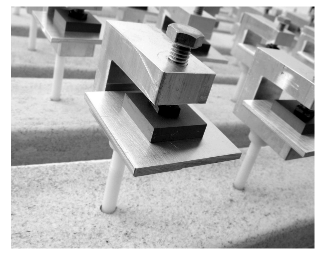

Fig 1.Coconut Island test site (marine site)

Description of the specimen	Coconut Island (marine test site) (gmd)	Manoa (wet test site) (gmd)
SiC/6061-T6 Al	0.015946	0.0041533
B_4C/6061-T6 Al	0.10091	0.083950
TiB_2/6061-T6 Al	0.054409	0.034579
AlN/6061-T6 Al	0.0056127	0.0058755
Si_4N/6061-T6 Al	0.014798	0.0024311