Evaluation of Coatings and Alloys to Extend the Lifetime of Equipment Used in Corrosive Environments

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Introduction

In acidic environments it is critical to engineer solutions to account for the depreciation of equipment caused by corrosion. Current commercial solutions that address corrosion are specialized alloys and coating

Coatings often are employed as acid-resistant barriers between the corrosive environment and equipment.

This presentation evaluates the performance of a silicon based coating in corrosive environments. Comparisons are made to non-coated stainless steel alloys.

Experimental

The following ASTM methods were run to evaluate the performance of coated and non-coated materials in corrosive environments:

- Pitting and crevice corrosion (ASTM G 48, Method B)
- 1000 Salt Spray Testing (ASTM B 117)
- Condensing Humidity Testing (ASTM D 4585)
- Cyclic Polorization Electrochemical Corrosion Testing (ASTM G 61)

Experiments conducted by Matco Associates (Pittsburgh, PA).

Results and Discussion ASTM G48, Method B Crevice Corrosion

Results from the pitting and crevice corrosion testing revealed that the silicon coated 316L stainless steel experienced no crevice corrosion and only slight pitting (figure 1a)

The bare 316L stainless steel coupons experienced severe crevice corrosion and pitting corrosion (figure 1b)

Table 1 summarizes weight loss resulting from exposure to the 6% w/w ferric chloride solution required by this method.

Elimination of crevice corrosion is an important step in reducing equipment depreciation in corrosive environments.

Figure 1a

Figure 1b

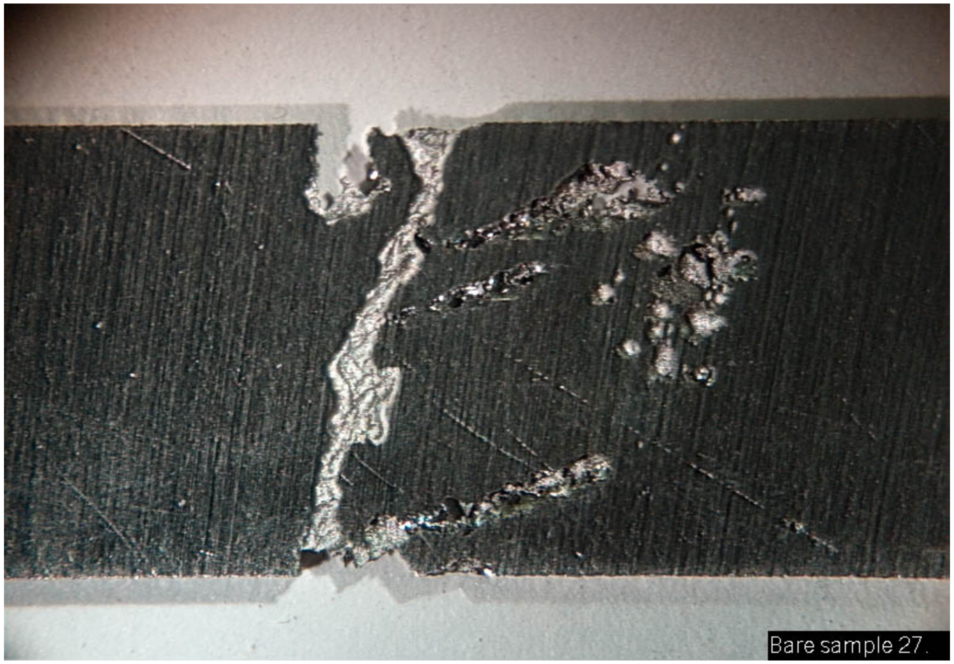


Table 1

- Weight Loss:

  Silcosteel®-CR treated 316L stainless steel coupons

- Sample 1: 19 g/m2
- Sample 2: 25 g/m2
- Sample 3: 25 g/m2

- Weight Loss:

  Bare 316L stainless steel coupon

- Sample 1: 231 g/m2
- Sample 2: 209 g/m2
- Sample 3: 228 g/m2

Results and Discussion
ASTM B 117
Salt Spray

- The 1000 hour salt spray exposure did not have any effect on the silicon coated 316L stainless steel samples (figure 2a)
- The bare 316L stainless steel samples exhibited light surface rusting but no signs of pitting (figure 2b)

Results of this study indicate the potential application of Silcosteel®-CR to enhance product lifetime and reduce equipment maintenance in marine environments.

Figure 2a

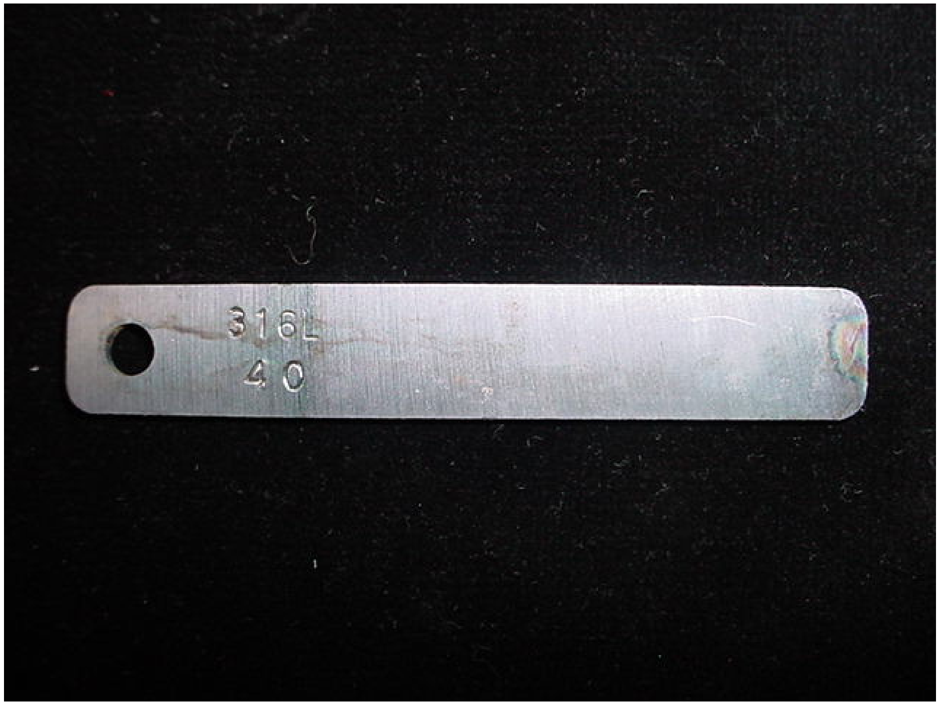
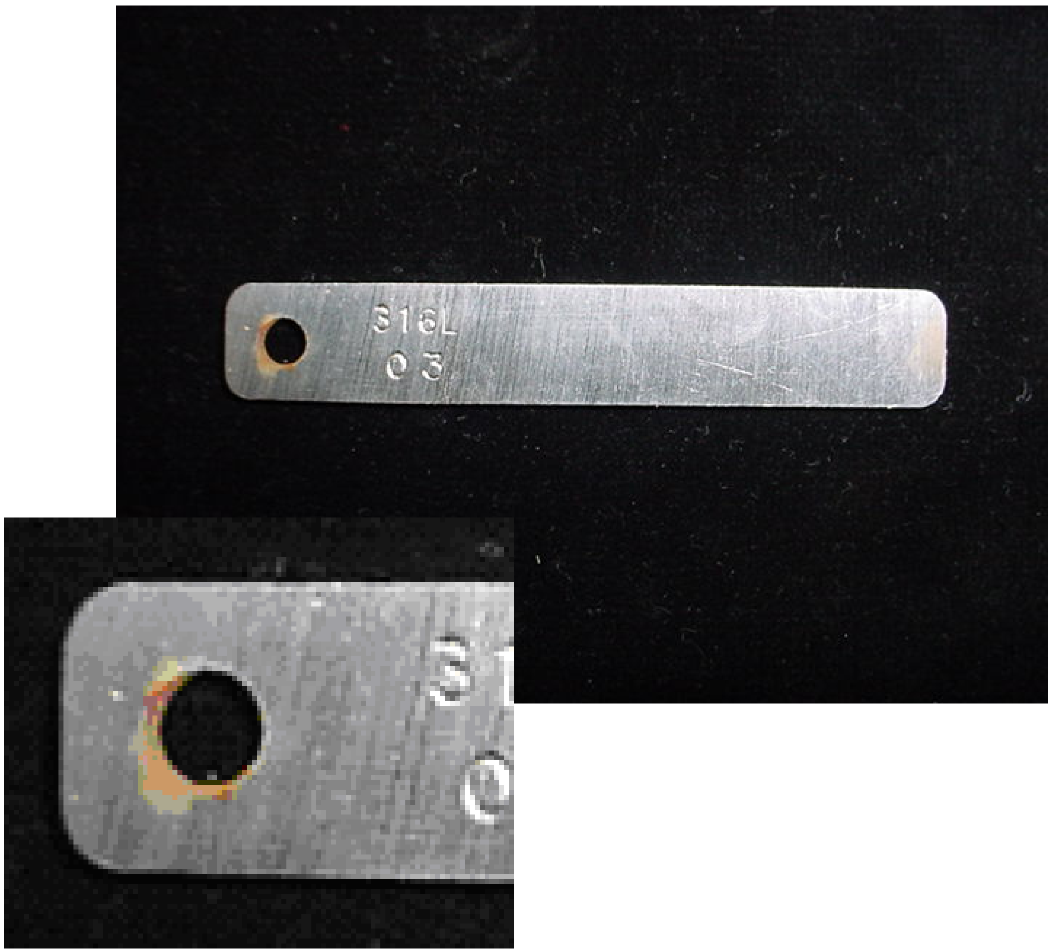


Figure 2b



Results and Discussion ASTM D 4585 Condensing Humidity

Exposure to condensing humidity had no effect on the silicon coated 316L stainless steel coupon (figure 3a) and produced only a slight oxide layer on the bare 316L stainless steel coupon (figure 3b).

This testing proved the stability of the Silcosteel®-CR coating in an environment designed to simulate outdoor applications of the coatings.

Figure 3a

Figure 3b

Results and Discussion ASTM G 61 Cyclic Polarization

Cyclic Polarization Electrochemical Corrosion Testing to evaluate the pitting potential.

Pitting Potential Eb, in millivolts, determined in a 3000ppm Cl- containing neutral solution:

- Silicon coated coupon: 1460mv
- Bare coupon: 370mv

Pitting potential, Eb, in millivolts, determined in a 3000ppm Cl- containing acidic solution (1N H2SO4)

- Silicon coated coupon: 927mv
- Bare coupon: 370mv

The increased energy required to generate pitting is the barrier towards corrosion supplied by the Silcosteel®-CR treatment.

Conclusion

Use of a silicon overlay coating dramatically improves the corrosion resistance of stainless steel components.

Improved resistance to attack acts to prolong components life and offer an alternative to expensive alloy solutions to corrosion.

The amorphous silicon coating, Silcosteel®-CR, has proven to extend resistance in marine exposure environments, chloride environments and is rugged and durable enough to withstand atmospheric exposure.