Evaluation of Atmospheric Corrosion of Bare Metals During a Two Year Outdoor Exposure

Y. Yoon[1], D. C. Hansen[1], J. Angel[2], W. H. Abbott[3], W. Culhane[1], L. Petry[1] and C. Joseph[1]

[1]University of Dayton Research Institute, University of Dayton, Dayton, OH 45469, USA
[2]AFRL/RXSA, Wright Patterson AFB, OH 45433, USA
[3]Battelle Memorial Institute, Columbus, OH 43201, USA

The effects of environmental and climatic factors on the atmospheric corrosion behavior of six different bare metals exposed at various field locations were investigated. This work presents the results for pure Ag, AA7075, AA2024, AA6061, pure Cu and 1010 steel coupons over a two-year outdoor exposure period in 8 different locations. The environmental and climatic factors include relative humidity, temperature, UV, ozone, seawater and the gaseous air pollutants such as SO_2, NO_2, NO, O_3 as well as particulate pollutants [1-3]. However the environmental and climatic factors of the chamber exposure for this study were relative humidity, temperature, UV, ozone and 5wt% NaCl. The result of the ASTM B117 test standard has been criticized over the years due to discrepancies with results of field exposures and apparent failures to predict service performance [4-5]. Therefore, an accelerated test protocol including environmental factors is needed to accurately predict the performance lifetime of materials.

Six bare coupons containing Ag, AA7075, AA2024, AA6061, Cu and 1010 Steel were analyzed before and after field exposures. There were eight outdoor exposure sites: Daytona Beach (FL), Pt. Judith (RI), East Coast Ship (DE), West Coast Ship (WA), Kirtland AFB (NM), Hickam AFB (HI), Tyndall AFB (FL) and Wright-Pat AFB (OH). Those coupons were installed at the exposure locations and retrieved every three months after exposure. The corroded surfaces of the retrieved samples were investigated by SEM and the chemical compositions of the corrosion products were determined by EDS.

Figure 1 shows a relationship between the following parameters: temperature, ozone, UV and relative humidity at hourly intervals from 1 – 7 June 2010. Despite daily variability of the weather condition, typical daily patterns were found. Ozone concentration, UV and temperature are correlated positively while RH was shown to have a negative relationship with Ozone concentration, UV and temperature over a daily pattern.

Surface and chemical analyses were performed on the field exposed coupons; an example of EDS spectra and SEM images of pure silver coupons exposed at the Daytona Beach (FL) site up to 24 months are shown in Figures 2 and 3. Before exposure, only pure silver element was detected. After exposure, the silver sample contained Cl and O elements at 3 months exposure and later O, Na, Mg, Al, Si as well as Cl were also detected. The surface chemical analysis and surface morphology of the other exposed bare metal coupons from the 8 exposure sites will be presented and discussed along with the results of the chamber exposure measurements.

References

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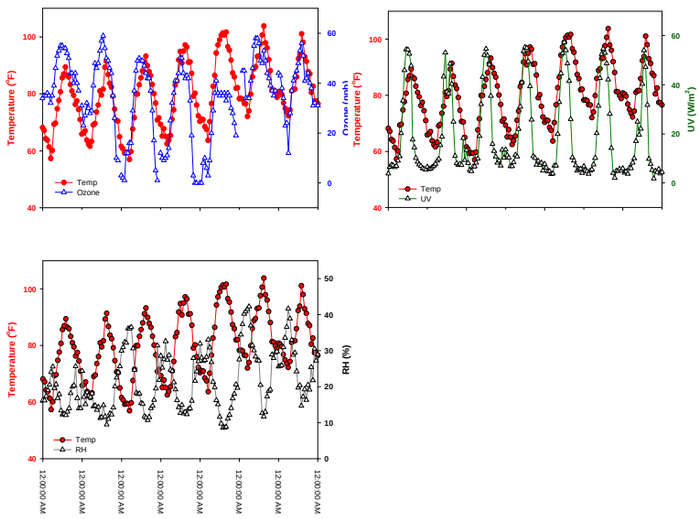

Figure 1. Temperature, ozone, UV and RH at Kirtland AFB from 1 to 7 June 2010

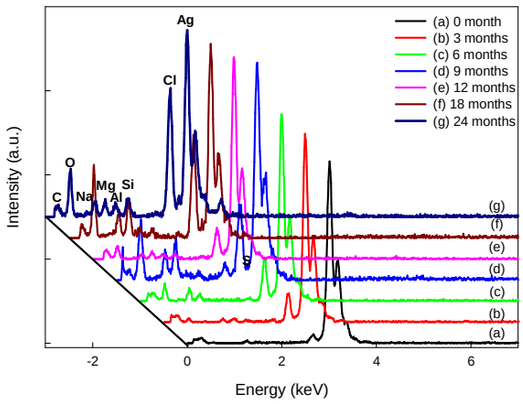

Figure 2. EDS spectra of the pure silver exposed in Daytona Beach, FL.

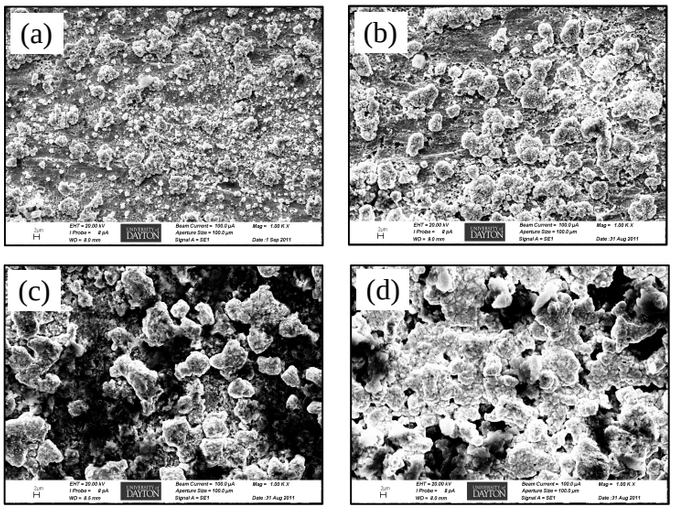

Figure 3. SEM images of the (a) 3 months, (b) 6 months, (c) 9 months, (d) 24 months pure silver exposed in Daytona Beach, FL (1000X Magnification).