Copper Metal Corrosion Studies from Diffusion of Sulfur-based Compounds Emitted from Defective Drywall

Spiderman S. Mulholland[1] and Ara Manukian[2]

U S Building Consultants, Inc., Analytical Research Systems, Inc.

ABSTRACT

Corrosion of copper metals from out-gassing of defective drywall found in homes has been a topic and scientific study as it relates to health and life safety issues. Conducting testing of metals under stringent controls in controlled laboratory conditions using known defective drywall imported from China showed significant development of sulfur-based corrosion products on copper metals compared to domestic drywall. Testing and analysis on copper metal samples using volatile collection equipment and material analysis by Scanning Electron Microscopy (SEM) / Energy Dispersive Spectroscopy (EDS) and X-Ray Diffraction (XRD) showed significant sulfur-based corrosion to copper materials. Extended studies using the same methodology and laboratory equipment is being conducted for long term corrosion studies to determine rates of corrosion based on exposure times and gas concentrations in addition to methods of chemical stabilization / neutralization of the gases for remediation purposes. Studies of corrosion levels are being done to validate differences between domestic drywall verses some Chinese drywall that has been known to cause copper corrosion in homes in Florida and other states. Sample testing method development and specialized equipment apparatus fabrication are being done in cooperation with US building Laboratories, Inc. (Gainesville, FL), Analytical Research Systems, Inc.,(Gainesville, FL), the University of Florida (Gainesville, FL), and E &S Consulting, Inc. (St. Augustine, FL). The metallurgical findings and material sciences analysis focus on the time and amount of deterioration that can be extrapolated over a life cycle period based on corrosion rate determination.

HADS

VSC

VCC

Copper Corrosion Test Apparatus used at ARS, Inc. for studying the affects of Chinese Drywall off-gassing on copper metal.

Experimental Apparatus:

The VCS equipment used consisted of three (3) main components (referencing above photo - from Left to Right) that were all connected in series using ¼" FEP-TEFLON Tubing to connect the three components described below.

The 1st component was a 2-Channel **Humidified Air Delivery System (HADS)** (P/N# VCS-HADS-2AFM1C), having two air outputs, and is used to purify compressed air using a packed activated carbon filter, control and maintain constant air pressure using a pressure regulator, set and maintain a constant air flow for quantifying total air volume delivered using two high precision adjustable 150 mm glass tube flow meters, and humidify the air using two all glass 150 ml water bubblers. All components of this system are made from glass, metal and TEFLON and do not use any plastic components in the air flow path since they are used for collecting volatile organic compounds (VOC's) from test samples for trace (PPT/PPB) chemical analysis by GC/MS.

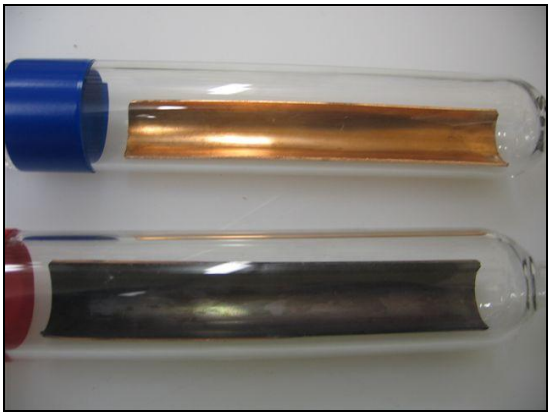
The 2nd components of the VCS are two **(2) Volatile Source Chambers (VSC)** (P/N# VCC-4550RV-14) which consist of two all Pyrex Glass chambers, approximately 50 mm in diameter and 350 mm long and have a 45/50 RodaViss joint connection for sample inlet. The front end caps have a glass porous frit fused into them to diffuse and provide a laminar air flow stream through the chamber. They are connected to the HADS using ¼" OD FEP-TEFLON tubing. These chambers are used to put the drywall samples in and allow the purified & humidified air from the HADS to flow across the samples and entrain any gaseous volatiles emitted by the drywall samples and sweep them out into the final component / test chambers (SEE BELOW) which are also connected in series with the same FEP-TEFLON Tubing.

The final and 3rd components of the VCS are two **(2) Volatile Collection Chambers (VCC)** (P/N# VCC-2440RV-6-NF) which also consist of two all Pyrex glass chambers that are approximately 25 mm in diameter and 150 mm long and have a 24/40 RodaViss joint connection for sample inlet. They have ¼" inlet & outlet ports to allow connection of the ¼" OD FEP-TEFLON tubing coming from the VSC's (ABOVE) and vent there gas flow out to atmosphere or can be connected to a gas detector or other instrument as needed on the outlet side. These chambers contain the test samples (copper metal strips) that are to be exposed to any volatile gases being emitted by the samples placed in the volatile source chambers (VCS) in front of the VCC's and passed through to them.

Experimental Method:

Using the above equipment, a 3 week (24 hrs per day for 21 days) exposure test was performed. Using high pressure compressed air at 150 psi supplied from the laboratory air compressor system was supplied to the Humidified Air Delivery System (HADS). The HADS outlet pressure was set at 15 psig and the humidifying bubblers where filled with distilled / de-ionized water. The outlet air flow rate was set at 1 liter per minute (1 LPM) for each of the two outputs and supplied to the two Volatile Source Chambers (VSC's). The humidity and temperature was constantly measured using a digital thermo-hygrometer (OMEGA P/N# HH314A) and averaged 75.5±1.0 deg.F and 94%±5% RH throughout the 3 week experiment. Two drywall samples were placed in the Volatile Source Chambers (VSC's) One was a Chinese Drywall sample removed from a private residence (USBCI, Sample ID# DD-ER 05-29-09) and was labeled with Red Tape & ID#, the other was a control which was a locally purchased (Home Depot) American Drywall sample produced by US Gypsum (USBCI, Sample ID# USG-02 06-18-09) and was labeled with Blue Tape & ID#. Both samples were exposed to the same air source for 3 weeks. The total air volume passed over the samples and through the chambers during the experiment was 30,240 Liters (1 LPM x 60 minute/hr x 24 hrs/day x 21 days) or 1,068 ft3 air volume per chamber. The VCC chambers containing the copper metal test strips were connected individually in series to the two separate volatile source chambers (containing the drywall samples) and each contained the same source sample of copper metal, a ¾" wide x 4" long piece of industry standard HVAC A/C ¾" soft copper tubing (IUSA ¾" REF 50' roll of soft refrigeration tubing, purchased from Johnston Supply, Gainesville, FL). Both copper samples were sectioned in half from the same ¾" tube and each piece of the two half's was rinsed and wiped clean of any oils with methanol and placed into their individual VCC's. Similarly labeled with Red & Blue tape and ID#'s to coincide with their respective VSC source ID#'s.

After 3 weeks of air exposure, the Chinese Drywall exposed sample (ID# DD-ER showed significant black discoloring while the USA Drywall exposed sample maintaining its original copper color (bright copper shine). (SEE PHOTOS)



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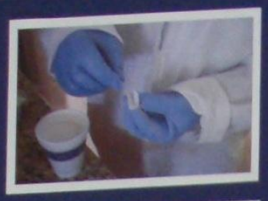

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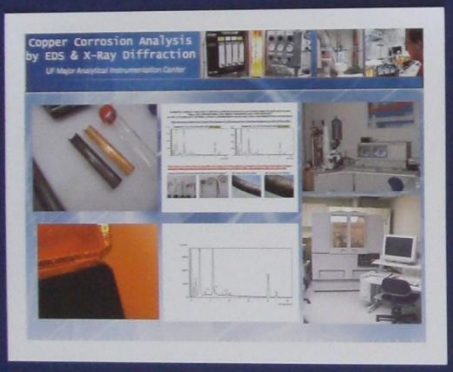

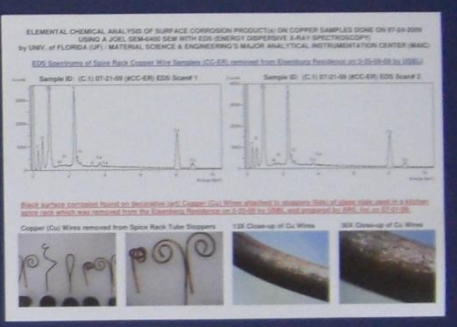

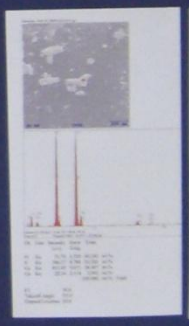

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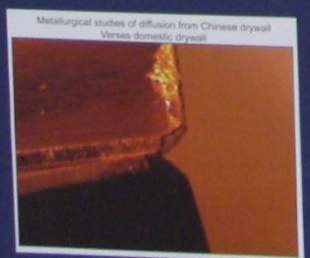

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