

# Results of Indoor Air Testing in Two Homes Experiencing Copper Corrosion Associated with Corrosive Imported Drywall

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## Introduction

Reports of rapid, recurring copper corrosion in relatively new homes, associated with the use of imported drywall, prompted concerns of associated health hazards by Florida public health officials. To further evaluate the potential for health effects, a study was prompted by the Florida Department of Health which measured chemical concentrations present in indoor air of two homes which met, and in two neighboring homes which did not meet, the case definition of affected homes.

## Objectives

• Determine if building characteristics for affected homes differ from unaffected homes.

• Evaluate the reliability and repeatability of available sample collection and analysis methods.

• Measure the in-home concentrations of corrosive gases emitted from defective drywall.

• Estimate changes in concentrations of corrosive gases and volatile organic compounds (VOCs) due to diurnal cycles.

• Evaluate the influence of chemicals in outdoor air and environmental conditions on indoor air chemical concentrations.

• Evaluate the presence and in-home concentrations of secondary by-products perhaps attributable to corrosive emissions from drywall reacting with other materials, coatings, adhesives, or chemicals in the indoor environment.

## Methods

Criteria for Tested Homes met the Case Definition for drywall associated corrosion, repeated AC coil failures, severe or chronic symptoms, and discernible odor, (no tobacco smokers)

Control Homes were selected based upon construction date, proximity, and no signs of drywall associated corrosion as per Case Definition, (no tobacco smokers)

Phase I: Two Sampling Events (Units 80, 81, and outdoors) AM & PM Sulfur-containing gases

Collection - 1L Tedlar Bags, collected using a lung sampler  
Analysis - ASTM Method D 5504-01  
Laboratory - Columbia Analytical Services

### Volatile Organic Compounds

Collection - Carbo-Pack B sorbent tubes via personal sampling pumps at 0.2 LPM  
Analysis - thermal desorption into a gas chromatograph with mass spectrometric detection (GC/MS)  
Laboratory - Air Quality Sciences

Phase II Sampled sulfur-containing gases and VOCs throughout a twenty-four (24) hour cycle within Unit 90 (Test) and Unit 91 (Control) homes. Two locations within each home plus outdoors.

Twelve (12) sampling events to evaluate possible diurnal effects on sulfur-containing gases.

Collection - Same as Phase I  
Analysis - ASTM Method D 5504-08  
Laboratory - Lakeland Laboratories, LLC (Courier to Lab)

### Volatile Organic Compounds (Same as Phase I)

Formaldehyde - 24 Hr Diffusion Badges (UMEX) analyzed by Galson Laboratories.

## Ninety Six Chemicals of Interest by Chemical Family and Concentration

Chemical Family	Chemical Name	Test			Control			Test			Control		
		Unit 80 Max (ug/m <sup>3</sup> )	Unit 80 Mean (ug/m <sup>3</sup> )	Percentage of Detection	Unit 91 Max (ug/m <sup>3</sup> )	Unit 91 Mean (ug/m <sup>3</sup> )	Percentage of Detection	Unit 90 Max (ug/m <sup>3</sup> )	Unit 90 Mean (ug/m <sup>3</sup> )	Percentage of Detection	Unit 91 Max (ug/m <sup>3</sup> )	Unit 91 Mean (ug/m <sup>3</sup> )	Percentage of Detection
<b>Alddehydes</b>													
	Formaldehyde**	43.9	58.9	100%	2.6	2.6	100%	1.20	1.10	100%	47.9	47.9	100%
	Nonaldehyde (Nonanal)	52 ppb	48 ppb	100%	15.28	12.74	100%	11.26	10.33	100%	107	97.9	100%
	Hexanaldehyde	12.2	18.29	100%	4.3	3.71	100%	4.50	5.58	100%	5.3	4.91	100%
	Chanic aciddehyde (2-Propenal, 3-phenyl)	3.2	2.63	100%									
	Methylsulfonic aldehyde (2-Propenal, 2-methyl-3-phenyl)	1.8	1.74	100%									
	Benzaldehyde, 4-methoxy-	1.3	1.04	90%	0.8	0.58	80%	0.40	0.28	33%	0.2	0.20	8%
	Propenal, 2-methyl (Isohexanal)	3.3	2.33	100%	3.7	3.26	100%	19.10	7.08	100%	2.5	2.26	100%
<b>Alcohols</b>													
	1-Hexanol, 2-ethyl	12.5	11.74	50%	4.9	4.07	90%	9.10	3.14	100%	5.9	5.36	100%
	2-Propanol, 1-ethoxy	5.8	4.78	100%									
	1-Butanol, 4-(tert-butyl) alcohol	4.5	4.12	70%	1.8	1.40	100%	12.70	6.90	100%	5	3.53	100%
	1-Propanol, 2-ethoxy	1.6	1.31	100%	0.1	0.10	20%						
	1-Propanol, 2-methyl (Isobutyl alcohol)	6.0	5.78	100%				4.98	2.70	100%	1.1	0.77	100%
	TXIB (2,2,4-Trimethyl-1,3-pentadiene diisobutylate)	1.4	0.46	9%	2.1	0.60	40%	2.10	1.34	100%	0.9	0.52	100%
	1-Octanol				3.8	3.53	70%	4.00	3.31	100%			
	2-Propanol, 1,1-methoxyethyl							3.70	3.13	100%			
	18479.85.8							3.40	2.84	100%			
	Ethanol, 2-ethoxy, acetate (2-Ethoxyethyl acetate)							1.10	0.86	100%			
	1,2-Ethanol, 3-methyl										3.1	3.00	25%
	Ethanol, 2-ethyl	0.21	100%		0.30	10%							
	Ethanol, 2-ethyl												
<b>Acids</b>													
	2-Methyl-Paracetamol (Methoxyacetone)	1.7	1.36	100%				0.80	0.68	100%			
	(S)-2-Hydroxypropanoic acid (lactic acid)	16.3	18.20	20%	7.3	3.18	50%						
	Propanoic acid, 2-hydroxy, ethyl ester	7.9	5.13	60%									
	Acetic acid (Acetic acid, methyl ester)	79.20	6.12	60%									
	Acetic acid, propyl ester (Propyl acetate)	109.40.4											
<b>Carboxylic Acids</b>													
	Propionic acid, 2-methyl (Isobutyric acid)	2.6	1.39	100%	1.8	1.43	100%	1.60	1.01	83%			
	Acetic acid, 2-methylpropyl ester (Isobutyl acetate)	1.4	1.13	100%	0.5	0.45	60%						
	Butanoic acid (butyric acid)	1.3	1.10	100%	1	0.83	100%						
	2-Propanoic acid, 2-ethylhexyl ester (Oxyol acetate)							0.30	0.28	33%			
	Propionic acid, ethyl ester	0.85	0.80	100%				1.62	0.90				
	Benzoic acid, methyl ester	0.56	100%								0.28	20%	
	Propionic acid, 2-methyl-, anhydride (Isobutyric anhydride)							0.47	100%				
	Butanoic acid, 3-methylbutyl-2-oxyl ester							0.60	92%				
	Fumaric acid (Maleic acid)	64.1	1.16					0.12	75%				
	Acetic acid, 1,7,7-trimethylbicyclo[2.2.1]hept-2-yl ester							0.36	75%				
	Formic acid, methyl ester							0.20	17%		0.20	17%	
<b>Alkanes</b>													
	2-Butanone (Methyl ethyl ketone, MEK)	7.5	6.53	30%	0.6	0.60	10%	6.80	5.22	50%	2.3	1.92	42%
	Bicyclo[2.2.1]hept-2-one, 1,7,7-trimethyl-, (IS)	4.9	4.23	70%	1.9	1.66	50%						
	Bicyclo[3.1.1]hept-3-one-2-one, 4,6,6-trimethyl-, (IS)-X	2.6	2.02	100%	2.2	1.68	100%	1.00	0.86	100%			
	Xetone	0.2	1.90	100%	0.6	4.71	100%	1.50	1.31	75%			
	2-Pentanone	2.1	1.83	100%	1	0.79	100%						
	2-Cyanohexan-1-one, 3,5,5-trimethyl-							0.63	33%				
	4-Bromocyclohex-1-en-1-ol, 1-(2,4,6-trimethyl-2-cyanoethyl)-, (E)-X	0.34	0.34	100%	0.60	10%							
	Cyclopentanone, 3-methyl							0.46	83%				
<b>Aldehydes</b>													
	Hexanoic acid, 2-ethyl-2,2-trimethyl-	49.8	34.00	100%									
	Octanoic acid, 2-ethyl-2,2-trimethyl-	26.7	26.71	100%									
	1,3-Butanedioic acid, 2-ethyl-2,2-trimethyl-	19.0	15.79	100%	0.3	0.30							
	Nonanoic acid, 2-ethyl-2,2-trimethyl-	19.6	15.76	100%									
	Hexanoic acid, 3-methyl	23.6	11.91	90%				0.40	0.38	50%			
	Undecanoic acid, 2-ethyl-2,2-trimethyl-	11.5	11.50	100%	5.3	5.10	20%	2.50	2.30	25%			
	Octanoic acid, 3-ethyl-2,2-dimethyl	11.5	9.33	30%				2.50	2.57	100%	4.6	3.84	100%
	Decanoic acid, 2-ethyl-2,2-trimethyl	11.0	9.30	70%	1.1	1.10	20%						
	Decanoic acid, 3-ethyl-2,2-dimethyl	7.7	6.43	100%									
	Hexanoic acid, 2-methyl	9.6	3.68	100%	4.1	2.02	100%	4.40	2.41	100%	1	1.00	8%
	2,2,4-Trimethyl-1,3-pentanediol monoisobutyrate	5.4	2.21	100%	10	4.42	100%	16.40	7.56	100%	1.6	0.78	100%
	Heptanoic acid, 2-methyl	2.8	2.20	20%	1.2	0.82	50%	1.80	0.83	75%			
	Octanoic acid, 2-methyl	0.3	0.20	30%									
	Cyclohexylmethane, dodecanemethyl	2.3	1.70	50%	2.3	2.00	20%	1.60	0.63	92%	0.2	0.20	17%
	Dodecanoic acid, 3-methyl	1.9	1.36	50%	1.4	0.82	50%						
	Cyclohexane, methyl	1.7	1.17	20%	0.8	0.68	40%	4.40	3.13	100%	1.6	1.37	100%
	Nonanoic acid, 3-methyl							2.70	1.96	100%			
	1-Nonanol	0.10	100%										
	2-Propanol, 2-methyl	0.14	100%		0.10	60%		0.50	17%				
<b>Aromatic Hydrocarbons</b>													
	Benzene, 1-chloro-4-(trifluoromethyl)-	15.0	14.16	100%									
	Styrene	6.3	5.18	100%	1.3	1.04	100%	5.00	4.52	100%	3	2.73	67%
	1,6-Oxodiolin, 7-methyl-3-methylene (Myrene)	5.4	4.63	30%	2.7	2.31	100%	2.60	2.10	100%			
	1-Indene	4.0	2.71	100%	1.8	1.50	90%	1.40	1.11	100%	0.9	0.80	8%
	Benzene, 1,2,3,5-tetramethyl	2.5	2.25	20%	0.7	0.70	10%	1.80	1.11	92%	1.4	0.73	92%
	4-tert-Butylbenzylidene acetate (Verterone)	2.9	4.24	100%	0.8	0.49	100%	0.60	0.47	100%	0.8	0.43	100%
	Benzene, 1-(4-dimethylamino)-3,5-dimethyl	1.7	1.81	100%	1.6	0.80	40%						
	Cetene, n-	5.7	1.55	60%	0.6	0.31	100%	0.60	0.40	92%			
	Thiophene, 2-methyl	1.8	1.54	90%	0.9	0.54	70%	1.80	1.00	87%			
	(+)-Camphore							1.70	1.35	75%			
	2-Furancarboxaldehyde, 5-(dimethylamino)							1.80	0.97	100%			
	4-Tert-butylcyclohexane	0.8	0.38	90%				0.29	0.29	100%			
	Thiophene, 3,3,3-trimethyl-1,1-diphenyl							0.19	0.19	50%			
	9,9-Dicyclohexylfluorene							0.40	0.40	100%			
<b>Polyaromatic Hydrocarbons</b>													
	Naphthalene	3.2	2.57	100%	0.9	0.73	40%	5.30	3.88	100%	2	1.70	100%
	Naphthalene, 2-methyl							0.52	100%				
	Dibenzoyl, 4,4',8,8'-tetramethylnaphthalene	0.38	0.30	100%	0.18	0.40							
<b>Sulfur Compounds</b>													
	Sulfur dioxide	0.11	100%										
	Carbon disulfide										1.7	0.27	25%
	Thiophene, 2-ethyl	3.7	2.46	100%	2.5	1.55	80%	4.80	3.18	100%	1.4	0.74	100%
	Tetrahydro-1,3-dioxane-2-dione							0.43	92%				
	Thiophene, 2-methyl							0.33	33%				
	Benzothiazole	2.1	1.53	100%	1.7	0.93	100%	1.60	0.99	100%	0.9	0.77	100%
<b>Ethers</b>													
	Furan, 2-methyl	6.30	5.80	80%				0.10	30%				
	Phenol, 3-(2,6,6-Triethylbicyclo[3.1.1]hept-2-one)	79.2	68.46	100%	46.0	40.92	100%	55.00	50.00	100%	54.3	50.02	100%
	Phenol, 6-(6-Dimethyl-2-methylbutyl-bicyclo[3.1.1]hept-2-one)	79.2	39.54	100%	15.2	13.93	100%	19.70	17.62	100%	17.3	15.84	100%
	Sum of Phenoxy Isomers	151.8	108.00	100%	61.2	53.85	100%	75.20	67.62	100%	71.6	65.86	100%
<b>Others</b>													
	1-Methoxy-2-propyl acetate							3.90	2.78	100%			
	2,6-Diethyl-2,6-Dimethyl-1,3-Cyclohexanone, 2,6,10,15,19,23-hexa	2.5	1.65	40%	1.1	0.80	20%						
	47-Methoxy-1H-Indene, 3a,7,7a-tetrahydro	1.3	1.14	90%	0.3	0.20	30%						
	Phenyl isobutyrate							0.90	0.65	100%			
	N-Nitroso-2-methyl-1-oxoimidazole							0.59	92%				
	Phenyl methyl ketone							0.38	38%				
	1,3-Dioxane, 2-methyl							0.38	100%				
	Pyrazine, 3-ethyl	0.20	0.20	100%									
	Pyrazine, methyl												
	TVOC (ug/m <sup>3</sup> )		622			296		379			318		
	Sum of Chemicals of Interest (ug/m <sup>3</sup> )		101.8										