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# *Evaluation of Zerust Film*

**To:** Customer

**From:** Cortec Corporation Laboratories
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**Project** #: 14-003-1125.bis

**Results reported by:** Brian Benduha
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**Approved by:**
Margarita Kharshan
Vice President of R&D

**Date:** January 21, 2014

**Goal:** Customer would like Cortec to test the various batches of Zerust film for emitting properties vs. VpCI-126 film with the same thickness. They would also like us to do humidity testing with these films.

**Sample Received:** 6" X 6" bags, 2.5mils
4" X 6" bags, 2.5mils
3" X 5" bags, 2.5mils
Note -all samples were received on 1-6-14, and in good condition

**Method:** VIA Test, CC-027
Humidity testing, CC-018 (ASTM D-1748)
Razor Blade Test, CC-004*
Nitrite/Nitrate Test*
$SO_2$ Test, CC-003*
FTIR analysis, CC-006
*Cortec Laboratory is not accredited for the test marked

**Materials:** VIA test kit, Razor blade test kit, $SO_2$ Test kit, Nitrite/Nitrate Test Strips, Paragon 1000 FTIR, VpCI-126 film (2 mils), and non-vci PE film (3mils)

**Procedure:** 1) The tests were conducted according to standard procedures for each test.
2) For humidity testing, carbon steel panels were sealed inside the film bags, and then hung vertically in the humidity chamber.

**Results:**

**Razor Blade Test- Carbon Steel Panels**

| Film Sample | Panel #1 | Panel #2 | Panel #3 | Pass / Fail |
|---|---|---|---|---|
| 6" X 6" bag, 2.5mils | Fail | Fail | Fail | Fail |
| 4" X 6" bag, 2.5mils | Fail | Fail | Fail | Fail |
| 3" X 5" bag, 2.5mils | Fail | Fail | Fail | Fail |
| VpCI-126 film, 2mils | Pass | Pass | Pass | Pass |
| Control | Fail | - | - | - |

**Razor Blade Test- Copper Panels**

| Film Sample | Panel #1 | Panel #2 | Panel #3 | Pass / Fail |
|---|---|---|---|---|
| 6" X 6" bag, 2.5mils | Fail | Fail | Fail | Fail |
| 4" X 6" bag, 2.5mils | Fail | Fail | Fail | Fail |
| 3" X 5" bag, 2.5mils | Fail | Fail | Fail | Fail |
| VpCI-126 film, 2mils | Pass | Pass | Pass | Pass |
| Control | Fail | - | - | - |

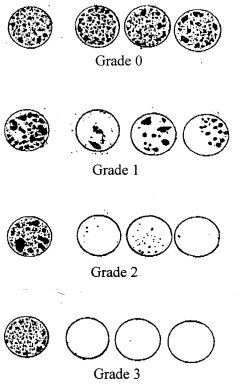
**Results Continued:**

**VIA Test**

| Film Sample | Plug #1 | Plug #2 | Plug #3 | End Result |
|---|---|---|---|---|
| 6" X 6" bag, 2.5mils | Grade 1 | Grade 0 | Grade 0 | Fail |
| 4" X 6" bag, 2.5mils | Grade 1 | Grade 1 | Grade 0 | Fail |
| 3" X 5" bag, 2.5mils | Grade 1 | Grade 0 | Grade 0 | Fail |
| VpCI-126 film, 2mils | Grade 3 | Grade 3 | Grade 2 | Pass |
| Control | Grade 0 | - | - | - |

VIA Test Grades (Grade 2 or 3 are passing)
All three plugs must be grade 2 or better to pass the test

Grade 0: Blind test
No corrosion inhibiting effect
Grade 1: Blind test
Minute corrosion inhibiting effect
Grade 2: Blind test
Medium corrosion inhibiting effect
Grade 3: Blind test
Good corrosion inhibiting effect




## Humidity Testing

After 250 hours in the humidity chamber, none of the samples being tested showed any signs of failure, so the test was ended. These same samples were then used for the $SO_2$ Test

**$SO_2$ Test**

| Film Sample | Results* |
|---|---|
| 6" X 6" bag, 2.5mils | Grade 1 |
| 4" X 6" bag, 2.5mils | Grade 2 |
| 3" X 5" bag, 2.5mils | Grade 1 |
| VpCI-126 film, 2mils | Grade 4 |
| Plain non VCI film, 3mils | Grade 1 |

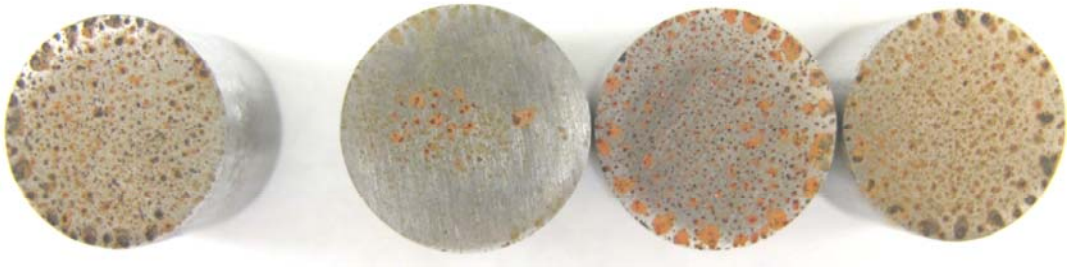
*Grade 3 and 4 are passing

Grade 0 - Extensive corrosion covering 25% or more of panel surface
Grade 1 - Moderate corrosion covering 10-25% of panel surface
Grade 2 - Slight corrosion 5-10% of panel surface
Grade 3 - Very slight corrosion 0-5% of panel surface
Grade 4 - No visible corrosion on panel surface

**Photos:**

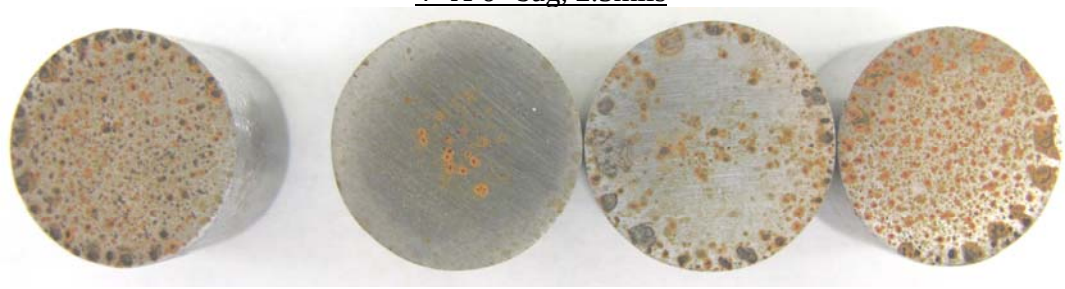
# VIA Testing

6" X 6" bag, 2.5mils



Control Plug#1 Plug #2 Plug #3

4" X 6" bag, 2.5mils



Control Plug#1 Plug #2 Plug #3

3" X 5" bag, 2.5mils

Control Plug#1 Plug #2 Plug #3

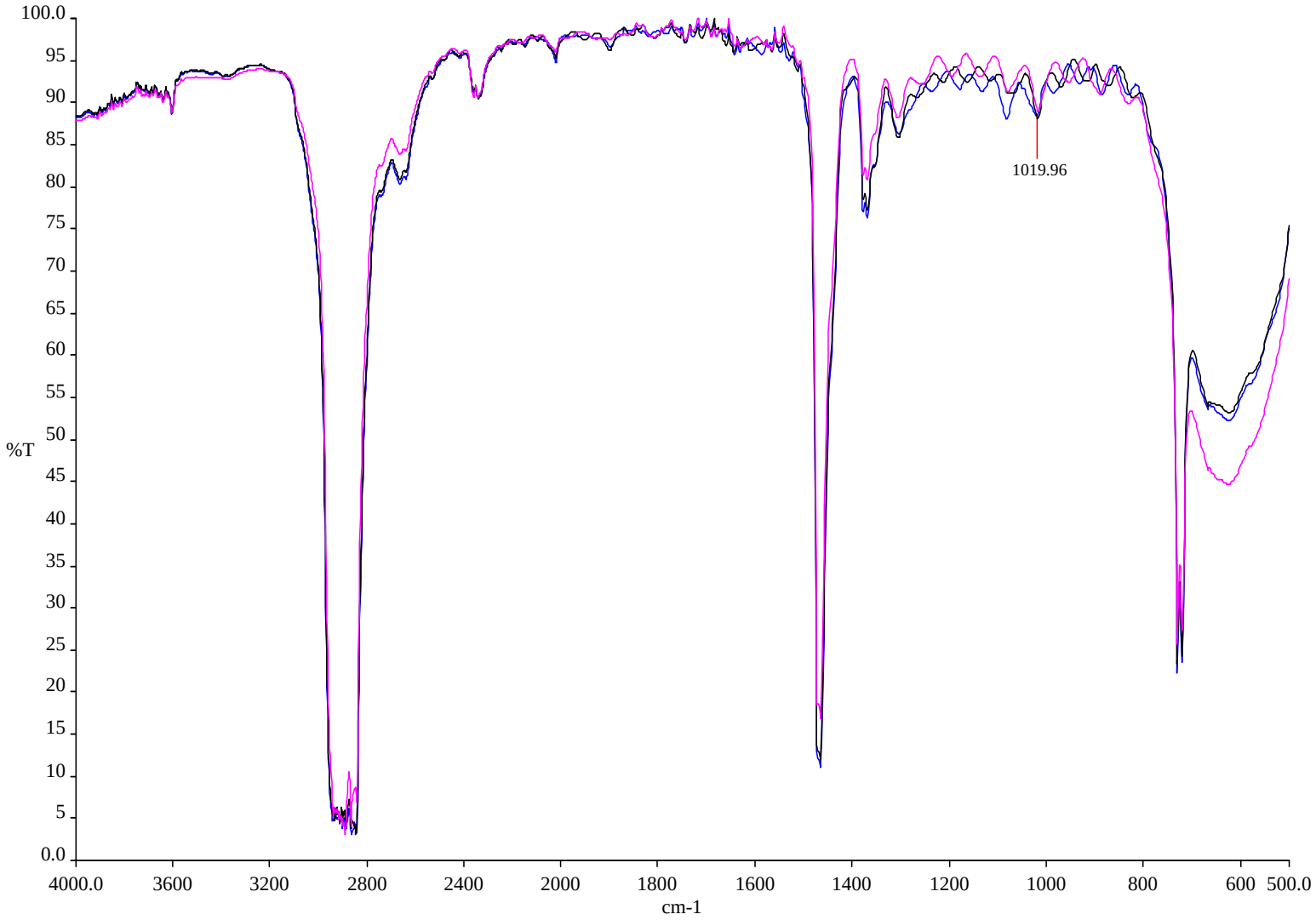
VpCI-126 film, 2mils

Control Plug#1 Plug #2 Plug #3

# FTIR Analysis

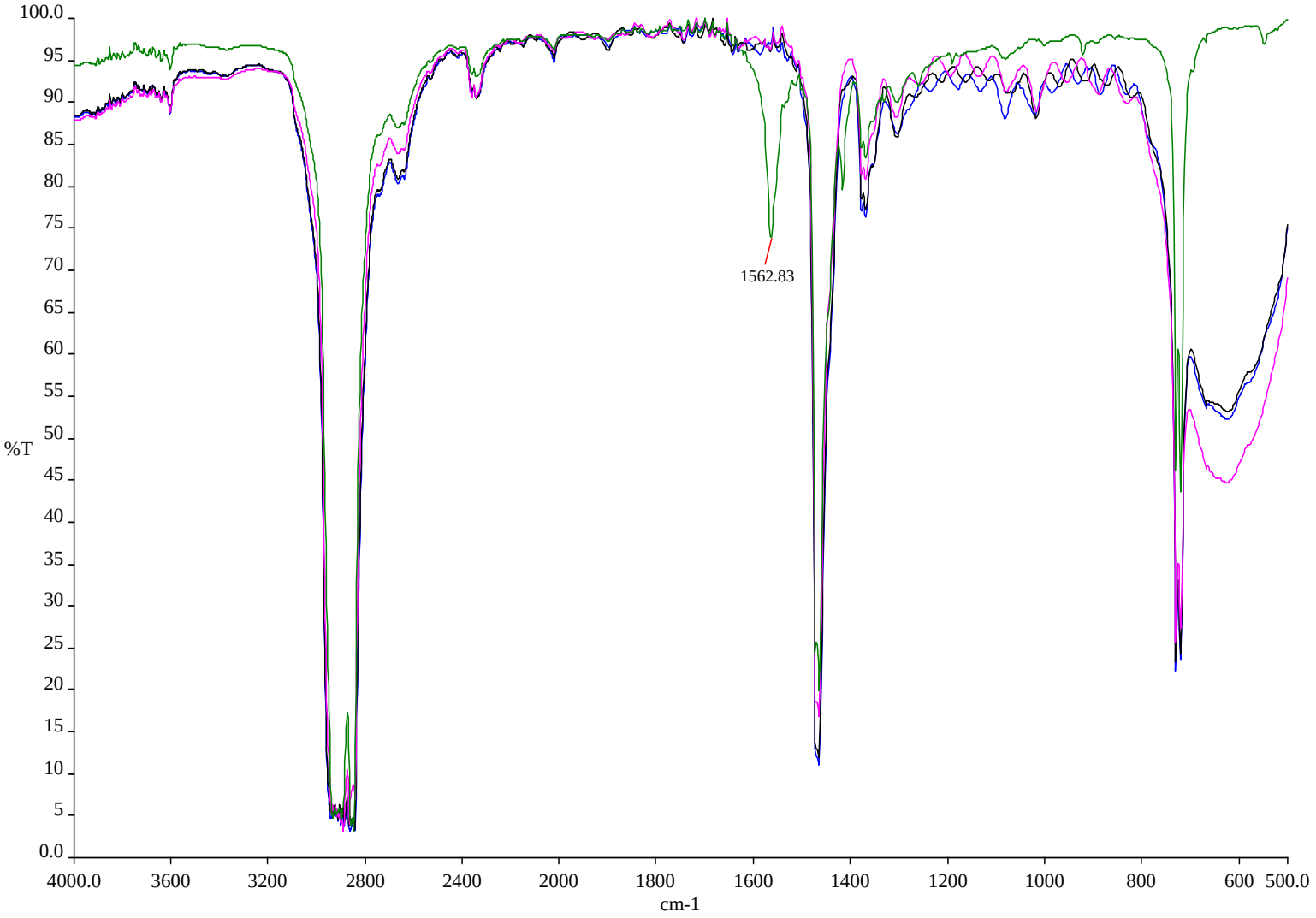
Comparison of all three submitted bags

(note- peak @ 1020 is possibly desiccant, but it's too small to know for sure)



# FTIR Analysis

Comparison of all three submitted bags and VpCI-126 film
(note- VpCI-126 shows the peak of corrosion inhibitor @ 1562.83)




**Interpretations:** The submitted Zerust film bags failed the razor blade test, VIA test, and $SO_2$ test. These films are primarily nitrite based and possibly contain a small amount of desiccant according to the FTIR analysis.