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Evaluation of Zerust Film and Desiccant Compared to VpCI-126 film and VpCI-130 foam

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Background: Noble Automotive, located in Turkey, is a component supplier for Ford. They are currently using Zerust film and desiccant for protecting their parts, and this system will be evaluated and compared to Cortec VpCI packaging products. The current products will be evaluated via multiple types of accelerated corrosion testing.

Sample Received: The following samples were received on 12/1/15 in good condition:
1) Parts and desiccant pack sealed in Yellow Zerust Film (3.5mils).
2) Parts and VpCI-130 foam sealed in VpCI-126 film (4mil)

Method: ASTM D-1735 Water Fog (100F, >95% relative humidity)
VIA Test, CC-027
Razor Blade Test, CC-004*
Nitrite/Nitrate Test*
FTIR analysis, CC-006
*Cortec Laboratories, Inc. is not ISO/IEC 17025 accredited for the test(s) marked.

Materials: VIA test kit
Razor Blade test kit
Nitrite/Nitrate Test Strips (lot #HC435784)
Paragon 1000 FTIR
Glycerol (lot #Q10A018)
Methanol (lot #041715D)
VpCI-126 film, 3mils (batch #410230)
Plain polyethylene film, 3.5mils (control film)

Procedure: The following procedure was used for the humidity testing:
1) Three parts were cleaned with methanol, dried, then sealed in VpCI-126 film (3mils) along with a piece of VpCI-130 foam measuring ten square inches.
2) Three parts were cleaned with methanol, dried, then sealed in plain polyethylene film (3.5mils)
3) The parts in the Zerust film were tested as received.
4) All parts were placed in the humidity chamber and tested until failure. Failure was determined by the first appearance of corrosion.

All other tests were performed according to their respective work instructions.

Results:

ASTM D-1735 Water Fog

Sample	Time to Failure
Parts sealed in plain polyethylene film (control)	16 hours
Parts sealed in Zerust Film with desiccant pack	120 hours
Parts sealed in VpCI-126 film with 2”x5” piece of VpCI-130 foam	236 hours

Razor Blade Test- Carbon Steel Panels

Sample	Panel #1	Panel #2	Panel #3	End Result
Yellow Zerust Film	Pass	Pass	Pass	Pass
Cortec's VpCI-126 film	Pass	Pass	Pass	Pass
Control	Fail	-	-	Fail

Razor Blade Test- Copper Panels

Sample	Panel #1	Panel #2	Panel #3	End Result
Yellow Zerust Film	Fail	Fail	Fail	Fail
Cortec's VpCI-126 film	Pass	Pass	Pass	Pass
Control	Fail	-	-	Fail

VIA Test

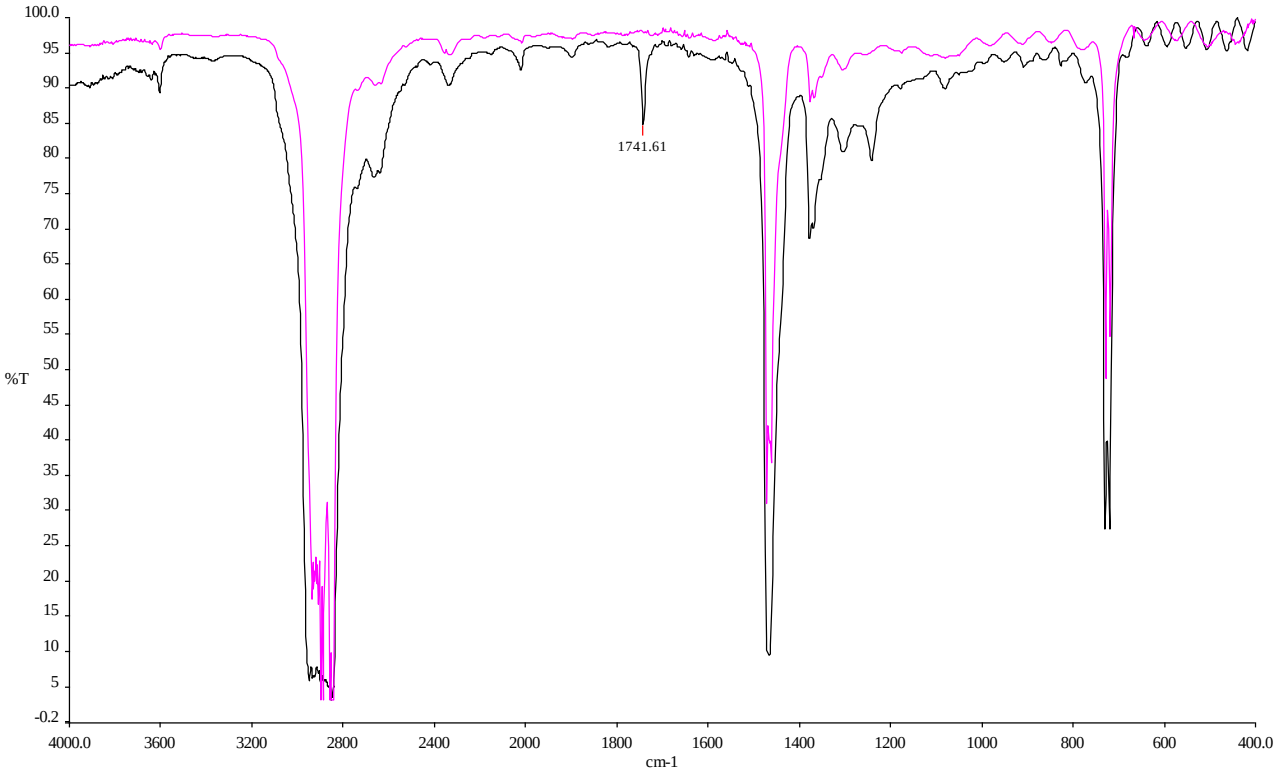
Sample	Plug #1	Plug #2	Plug #3	End Result
Yellow Zerust Film	Grade 2	Grade 2	Grade 2	Pass
Cortec's VpCI-126 film	Grade 3	Grade 3	Grade 3	Pass
Control	Grade 0	-	-	Fail

Nitrite/Nitrate Test Strip Results

The yellow Zerust film contains nitrite and nitrate on both sides of the film

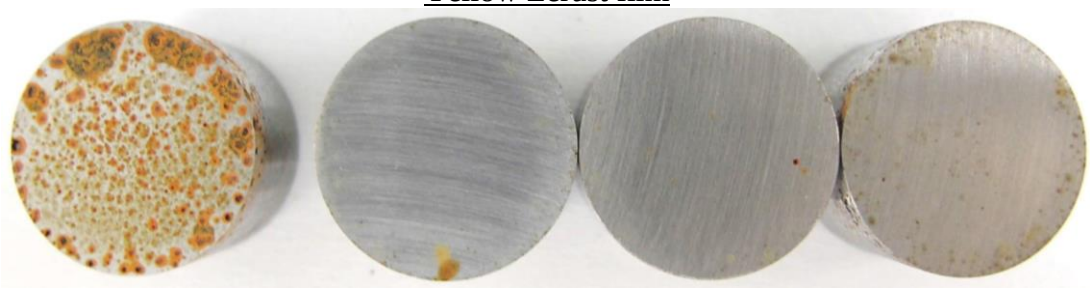
FTIR Analysis

Yellow Zerust film compared to plain PE film



Photos from VIA Testing:

Yellow Zerust film



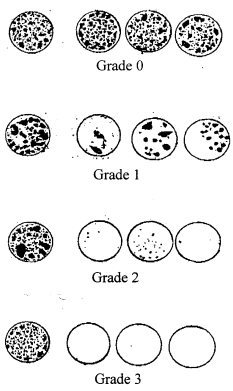
Control Plug #1 Plug #2 Plug #3

Cortec's VpCI-126 film

Control Plug#1 Plug #2 Plug #3

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



Photos after 236 hours of Humidity Testing:

Control parts sealed in plain polyethylene film

Parts sealed in Zerust Film with desiccant pack

Parts sealed in VpCI-126 film with 2”x5” piece of VpCI-130 foam

Interpretations: The results of the testing conducted in this report show that Cortec’s VpCI-126 film provides far superior corrosion protection when compared to the submitted Zerust film. The razor blade test, which determines contact corrosion protection, shows that VpCI-126 film provides multimetal protection whereas Zerust’s film only provides protection for carbon steel, but not for copper. Cortec’s VpCI-126 film also offers better vapor phase protection (VIA), and according to the humidity testing, when combined with VpCI-130 foam, the submitted metal parts were protected almost twice as long as those sealed in Zerust film with desiccant.