

## Analytical Sciences

### RE: **Sample Report – Analysis on Discoloration of In-Mold Waterborne**

One car seat coated with in-mold waterborne coating was submitted to Red Spot Analytical Sciences to determine the root cause of the car seat turning orange. The customer was concerned that the use of cleaning wipes the parts was turning them orange. Inspection of the part showed the interior areas of the car seat were more strongly discolored than areas along the bottom and the outside rim as seen in Figure 1. Areas with the expected white appearance were wiped with different cleaners in an attempt to replicate the issue but were not observed to have any significant changes.

Film builds on the car seat were measured using ISO 2808 method 6A version 2. The film builds of the discolored area were determined to be much lower at 7.58 microns than compared to the control area film build of 36.36 microns. Cross sections on these areas in Figure 2 showed variance in the coverage over the substrate regardless of the overall appearance. Control areas were found to have spots with little coverage over the substrate but not to the same extent as the discolored areas.

FTIR spectroscopy was performed on the discolored areas of the car seat and compared against the control. Analysis of the discolored areas of coating detected materials that matched the substrate as well as other unknowns. Subtractions were made between the collected spectra and identified the remaining peaks present to silicone. The FTIR spectrum of the waterborne did not have a silicone peak and was believed to be sourced to the mold release for the parts.

SEM-EDX spectral analysis was used to determine whether the silicone was localized to only the exposed substrate. Scans on the discolored area demonstrated a high concentration of several elements in discrete locations, indicating that the coating was not uniform across the part. Elemental silicon from the mold release was found in all areas of the part but in higher concentrations in areas with the orange appearance. Silicone is not known for reacting with polyurethane foam and was not believed to be directly responsible for the discoloration. Its presence primarily in discolored areas meant it was likely connected to the thickness of the waterborne coating.

Inspection under optical microscopy was conducted to isolate the relationship between the coating and the appearance. A knife was used to scrape the coating off the substrate and look for the effects of discoloration in both the coating and the substrate. The test was to determine if the discoloration was connected to a failure in the coating or a reaction in the substrate. Removal of the coating from the foam increased the amount of orange discoloration observed. This indicated that the discoloration occurred in all areas of the seat but could only be observed in areas without the coating over the substrate. Further



testing was conducted to understand whether a component from the cleaning products could be affecting the coloration of the substrate.

Slices were made on different sections of the substrate and showed that the foam was discolored directly beneath the coating region. Sections of the uncoated substrate were soaked in different common cleaning solvents to test if the discoloration could be recreated at deeper layers. Soaking with the solvents were shown to affect the structure of the substrate and cause discoloration. It was believed that the low film builds and inconsistent coverage of the part in areas allowed for the migration of these solvents to discolor. Areas with higher concentrations of silicone due to mold release corresponded to these low film build areas and was determined to be responsible for the poor coverage over the substrate.

If you have any additional concerns, please contact the department.

Regards,

Tom Hardin  
Analytical Chemist  
Analytical Sciences Department  
Red Spot Paint & Varnish Co

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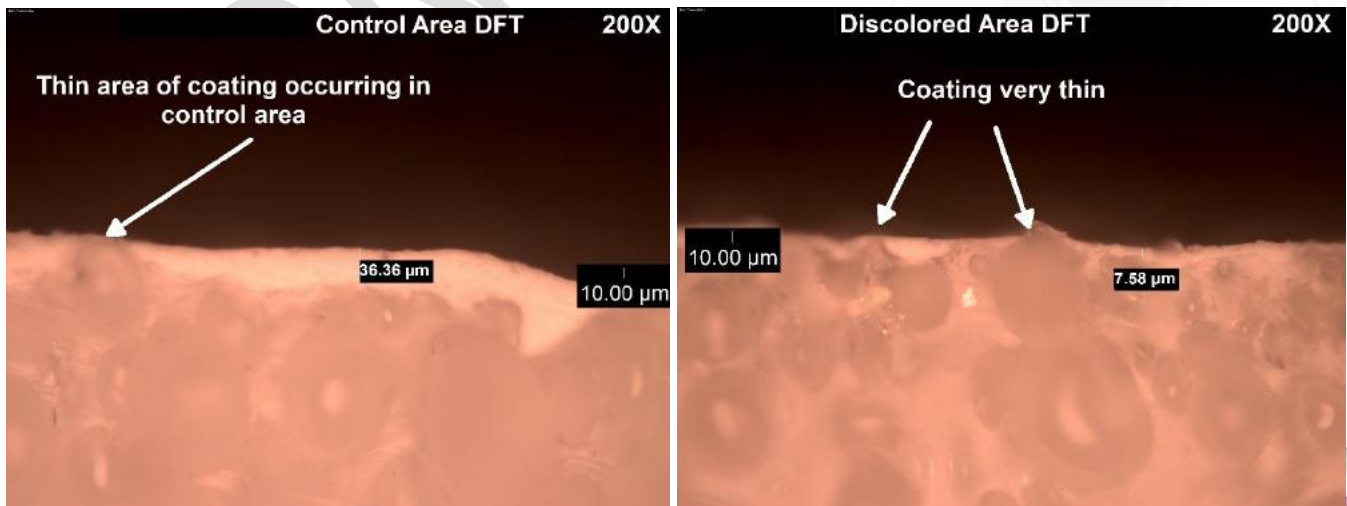


**Spectral Results:**

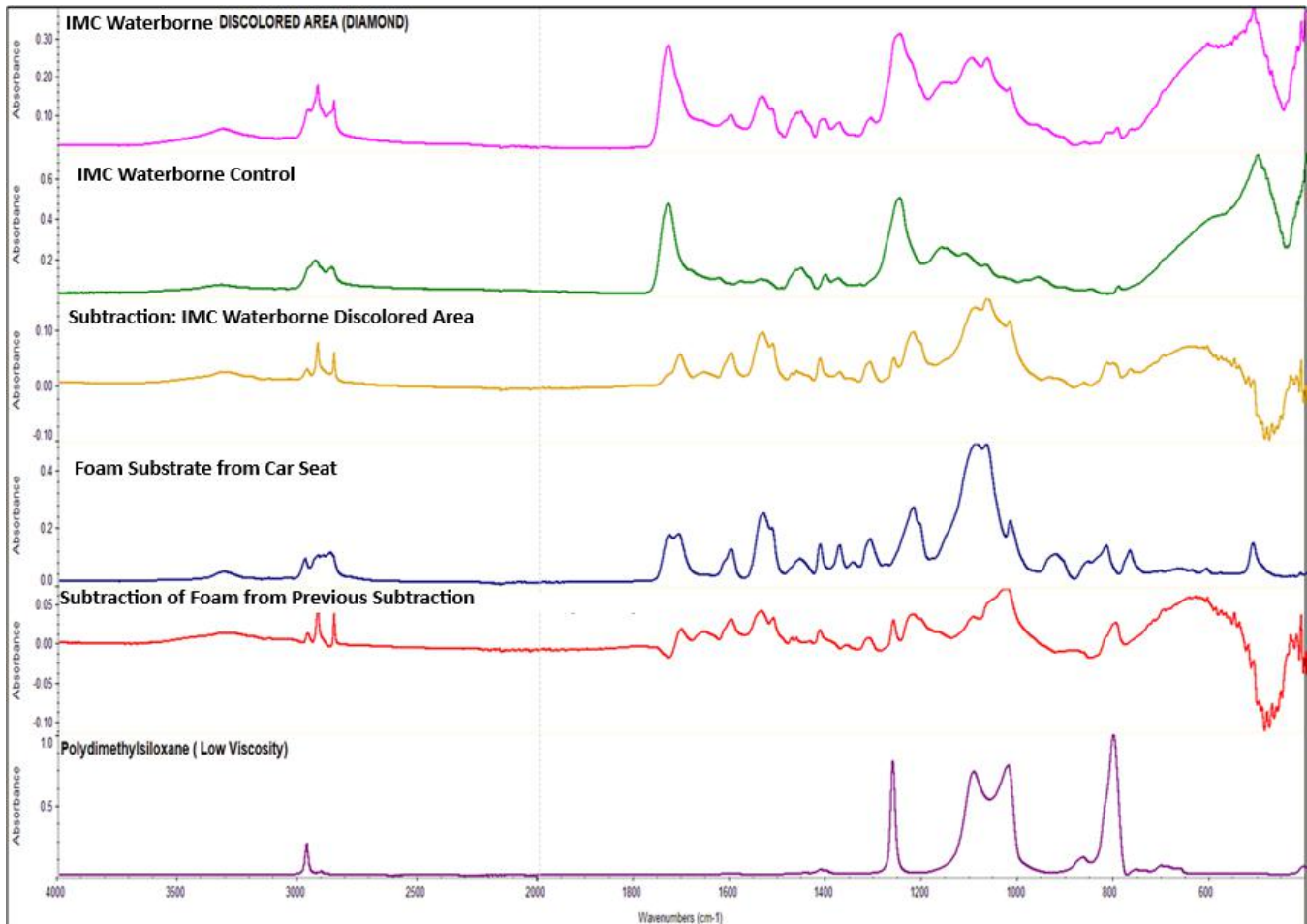
**Figure 1 – Photograph of Submitted Part**



**Figure 2 – Cross-sections of 558W52 on Car Seat**



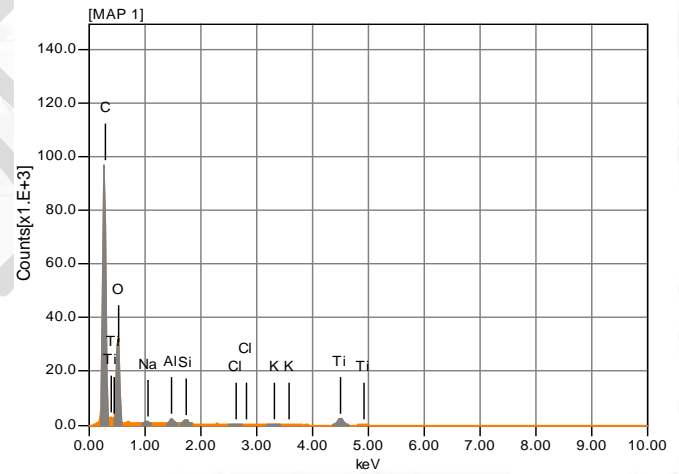
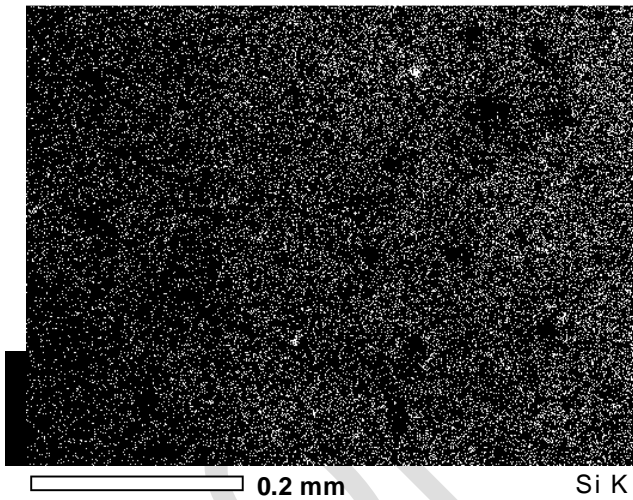
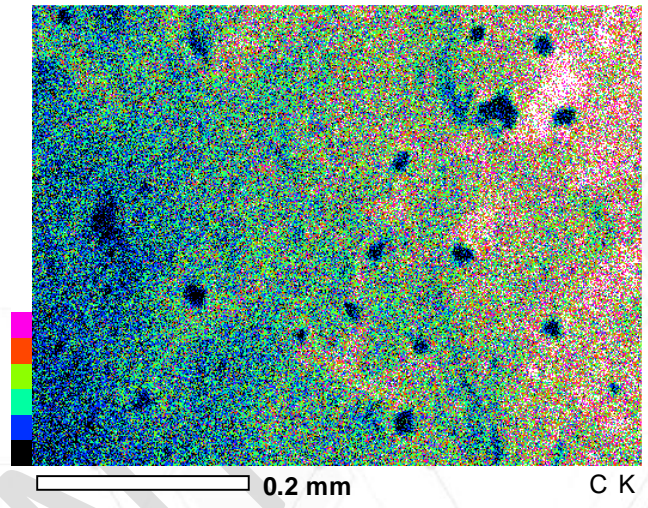
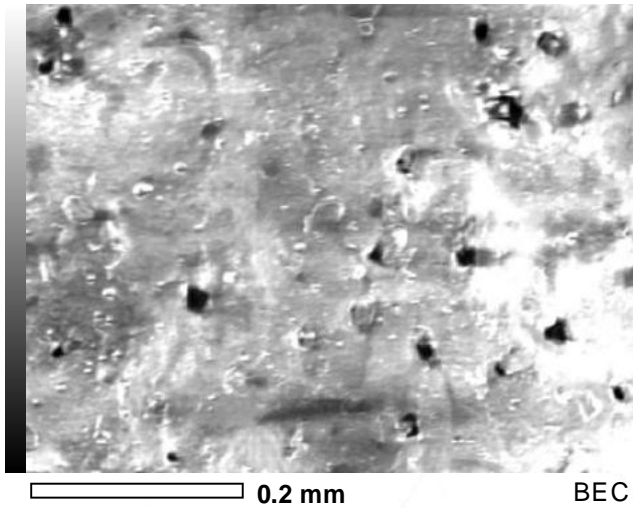
## Figure 3 – FTIR Spectra of IMC on Car Seat Against Knowns



Initial FTIR analysis showed extra peaks present that were not explained by the coating itself. The subtraction in line 3 indicated that some of the peaks corresponded to the polyurethane foam substrate. Further subtractions were able to detect silicone, a known mold release additive. Comparisons were made between the discolored areas and areas with good appearance and found little evidence of the polyurethane substrate or silicone present in the good areas.



**Figure 4 – SEM-EDX Spectra of IMC in Discolored Area**

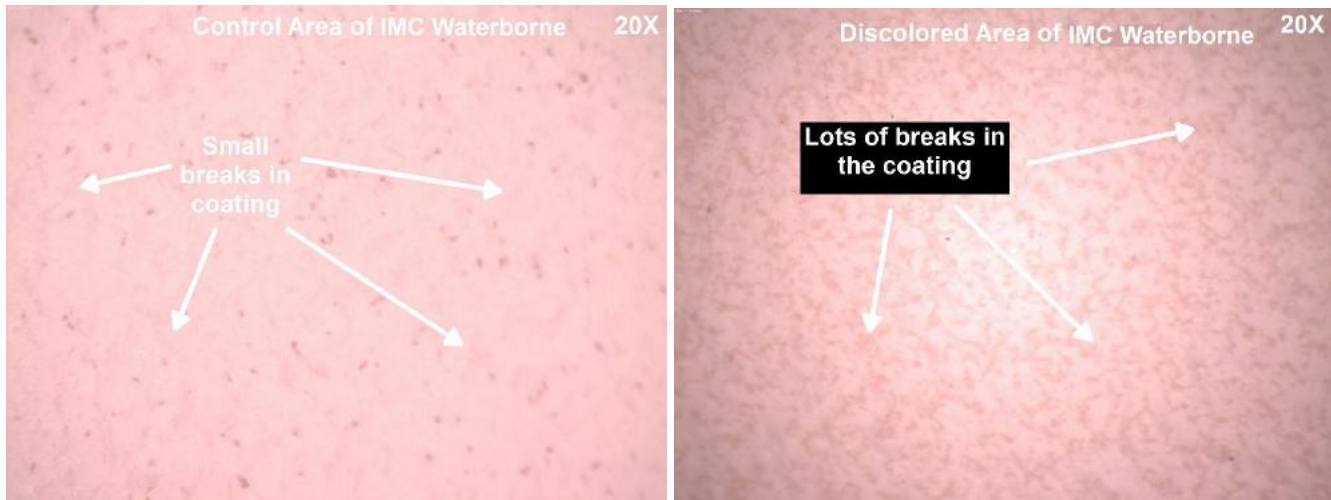


Formula	mass%	Atom%	Sigma	Net
C	60.87	68.80	0.01	2404031
O	35.11	29.79	0.03	805952
Na	0.21	0.12	0.00	20316
Al	0.57	0.29	0.01	53150
Si	0.35	0.17	0.00	56270
Cl	0.07	0.03	0.00	9037
K	0.09	0.03	0.00	8683
Ti	2.74	0.78	0.01	160199
Total	100.00	100.00		

K ratio	Line
0.0950597	K
0.1181956	K
0.0016687	K
0.0056123	K
0.0038789	K
0.0008807	K
0.0011803	K
0.0308004	K



**Figure 5 – Photomicrographs of Inconsistent Coverage with IMC**



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