TR21.01 Nonconformance Investigation, Root Cause Analysis, and Corrective Action

Define Problem:

For automotive paint proficiency test CTS21-5451, two analysts had unsatisfactory performance based on the discrepancies between their conclusions and the results released by the manufacturer.

Investigate and Find Causes:

Per the manufacturer's information, the test design was that of 3 paint samples (Item 1 = known sample, Item 2 and Item 3 = questioned samples) that were prepared from the same automotive paint panel.

Based on the data obtained from FTIR imaging of the paint systems of Items 1, 2, 3, both analysts determined there were observed differences in at least one paint system.

Analyst A determined Item 2 was inconsistent with Item 1; however, he did correctly associate Item 3 with Item 1 based on consistencies in the paint data.

Analyst B determined both Item 2 and Item 3 could have originated from the same source, but both were inconsistent with Item 1, based on all his data.

Upon QM review on 7/27/21 (post-test, once manufacturer results were announced), the data in each case file appeared to support each analyst's conclusions. Both analysts performed replicates, as indicated in procedure, so the conclusions were not based on one outlying spectrum. Given that nobody in QM is qualified in paint analysis, an outside consultant was sought to offer expertise in the matter.

On 7/31/21, Dr. Edward Suzuki was procured to review the data and offer his interpretation, without being told from where the samples or data came, or what were the circumstances.

On 8/4/21, Dr. Suzuki drew the same conclusions as Analysts A and B did after looking at their data. This confirmed the issue was not with the analysts' interpretation abilities.

The instrument underwent maintenance on 6/28/21, and the detector was ultimately replaced. The proficiency samples were re-run once this non-routine maintenance was completed, and the data did not look much different. Although Dr. Suzuki later gave his opinion on the chosen method for analysis (to be discussed later), an instrumentation failure was not the cause of this nonconformity.

Upon further investigation in Analyst B's original activities during the test, we discovered he had inadvertently labelled Item 2's raw data as Item 3, and imported that data under Item 3 for subsequent analysis. Therefore, the results he reported to the manufacturer for the questioned

samples were two Item 2's. This explained the different answer he got for Item 3. Analyst B stated he was pressed for time and was struggling to meet the deadline of the proficiency test that week.

Sample preparation still remained to be the area possibly at fault. Dr. Suzuki and the analysts all saw differences in bandwidth and intensity near 1000 wavenumbers for Item 2. On a conference call with Dr. Suzuki on 8/18/21, there was a discussion about interfering substances resulting from the sample preparation procedure. An aluminum oxide component could show up in this region of the IR spectrum.

The analysts use a colloidal alumina suspension to polish the mounted samples. The analysts suspected some of this alumina was preferentially absorbing onto the surface of certain paint layers and getting detected during IR analysis.

When the analysts re-polished their samples, the artifacts previously showing up around the 1000 cm-1 mark did not show up. One re-run showed the same artifact in a different layer.
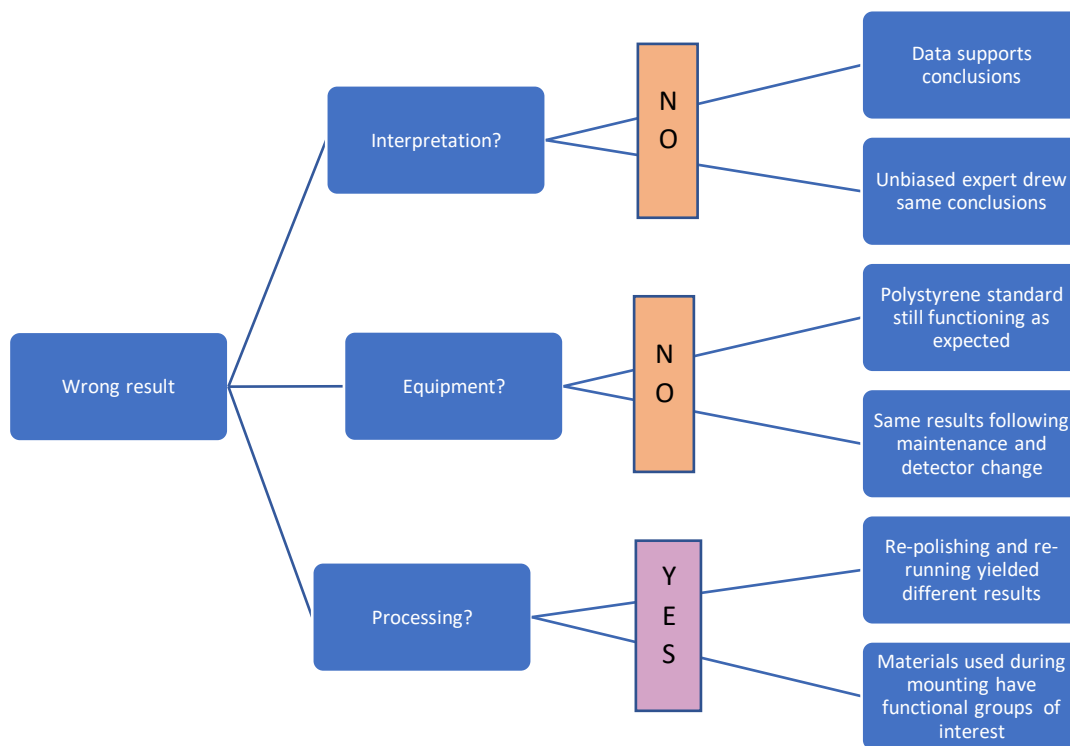
Root Cause:

The alumina suspension used during the final polishing step has the potential to leave a residue in certain paint layers, which gets picked up by the detector. Although a rare occurrence thus far, diligence during sample preparation is key. Both analysts, who rarely perform the paint sample preparation steps during casework, were rushing to finish their proficiency tests to meet the submission deadline (as evident by one analyst mislabeling one sub-item for another).

Find Solutions:

Either replace the alumina suspension with a diamond suspension to prevent residue from interfering with analysis, or insert a washing step to remove the alumina residue after the polishing step. Additionally, any suspected artifacts in future casework will trigger further sample preparation.

Corrective Action:

-Purchase a micro organic soap to apply after the polish to remove any micro-contaminants.

-Add washing step to SOP once detergent is tested and verified to work as intended.

-Re-prioritize proficiency test assignments, so deadline for completion is set earlier than manufacturer deadline for submission and analysts start earlier on assigned tests.

-Notify accreditation bodies of proficiency test outcome and investigative results.

-Notify customers of halted analysis while investigation is ongoing.

Impact on Casework:

In total, 31 paint cases were completed from November 2017 through June 2021 (excluding proficiency tests). All results have been reviewed to determine if this alumina interference could have occurred or affected interpretation. 22 cases involved screening clothing for paint chips, where no paint chips were identified. Six cases involved paint chips analyzed, but no usable data was obtained for comparison (e.g., not automotive paint, not sufficient quantity, etc.). Three cases involved one paint chip analyzed with usable data; however, no other evidence was submitted for comparison and no potential vehicular hits obtained from a PDQ search. Therefore, this nonconformance had no impact on past casework. In the event a suspect vehicle is identified for any of the three cases with a chip from the scene analyzed, attention will be paid to ensure micro-contaminants do not interfere with future analysis and comparisons.

Further Discussion:

Dr. Suzuki stated the attenuated total reflectance (ATR) spectroscopy used by HCFIS is less popular than transmission spectroscopy among IR users for forensic automotive paint analysis and sent literature highlighting that fact. Switching methods of analysis should be explored in the future to widen the pool for outside peer review and simplify the associated PDQ protocol.