This is a widget. (illustrations by Teresa Mibeck)

A Tale of Two Labs: Same Samples, Different Results

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Widget Manufacturing's Paint Problem

Widget Manufacturing Inc. had a crisis on its hands. Their painted aluminum widgets were failing in the field—the paint was peeling off after just months of installation. This coincided suspiciously with their recent decision to switch aluminum suppliers to reduce costs. With warranty claims mounting and their reputation on the line, they needed answers fast.

The root of the problem was supposed to be simple: a chromate conversion coating that creates a chemical bond between the aluminum and primer. Widget knew their original supplier dipped the aluminum in a chromium solution, while the new supplier switched to spraying the treatment. But was this change causing the failures? Or had the chromium migrated into the primer, gone too deep into the aluminum oxide layer, or disappeared entirely? Did a contaminant in the aluminum or paint interfere with the treatment?

Act I: Plug-n-Chug Laboratory

Widget Manufacturing first turned to Plug-n-Chug Laboratory, a testing lab known for quick turnaround times and competitive pricing. Widget Engineers sent two unpainted aluminum samples: one from the new supplier and one from their previous supplier as a control (paint intact). They asked Plug-n-Chug scientists to detect how much chromium was on the surface of each sample. Plug-n-Chug's approach was simple:

1. Mount the samples in the SEM chamber
2. Focus on the surface
3. Run standard EDS analysis
4. Generate a report

The verdict returned within 48 hours: "No chromium detected on either sample." Of course, this is incorrect—there had to be chromium in the control sample. Unsure where the problem lay, Widget paid the invoice from Plug-n-Chug lab and continued to look for answers.

Act II: Problem-Solving Labs Inc. Asks Questions

Frustrated and still facing mounting failures, Widget Manufacturing approached Problem-Solving Labs Inc., a research-oriented facility known for tackling complex analytical challenges.

The first meeting at Problem-Solving Labs was different. Instead of immediately accepting the samples and rushing to analyze them, the team asked many questions:

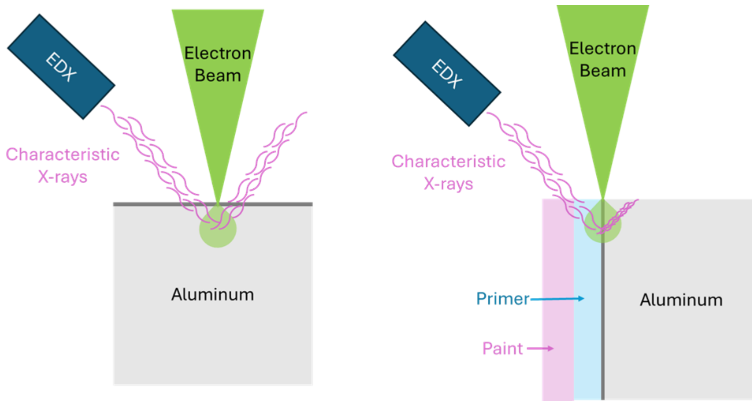
Trent (Research Manager) and others at PSL: "What aluminum alloy was used?", "How is the aluminum painted?", "What colors are used? How many layers? How thick is each layer?", "Are all parts being returned, or are they only from certain climates?", "Did Widget conduct exposure testing?", "How are the layers cured?", "What steps are performed at Widget? What steps are taken by the supplier?", "How is the aluminum coated with a chromium solution? How long before they are painted?", "How thick would you expect this chromium conversion layer to be? How thick does it need to be? And how did the other lab analyze your samples?"

Widget Engineers provided all the answers they could.

Problem Solving Scientists communicating with Widget Engineers.

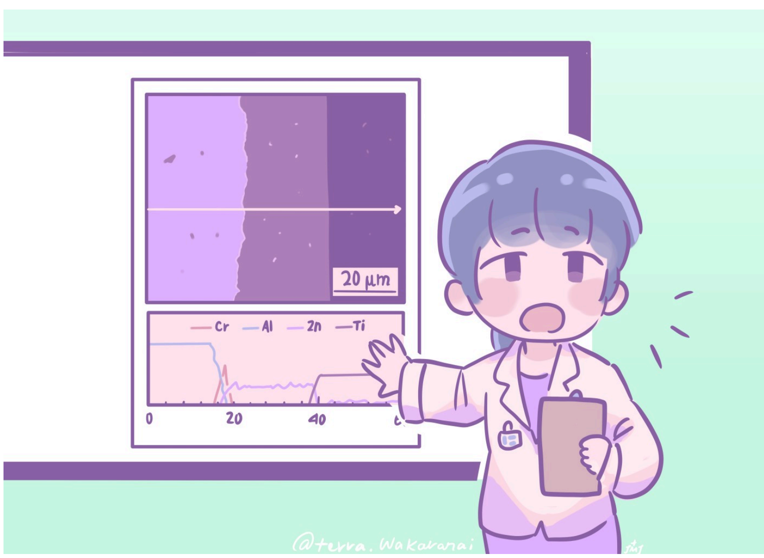
Alice (PSL's subject matter expert on SEM-EDX): "The characteristic x-rays used to identify elements come from deep within the sample, especially if the top surface is mostly light elements like those in paint. The beam width at the surface is small, but the interaction volume can be pretty wide. A thin layer of chromium could be missed...We should try cross-sectioning painted samples, mounting them in epoxy, and polishing. This would make the chromium layer appear thicker to the electron beam. We must orient the paint side towards the EDX detector so the chromium x-rays have a line of sight to the detector window through the lighter paint layers."

After carefully cross-sectioning the samples, PSL technicians polished them until they looked like mirrors! Alice began investigating by collecting SEM images. Spots and region spectra of each layer came next. Finally, she performed line spectra drawn across these layers. She adjusted the SEM-EDX settings to optimize the line spectra for the highest linear resolution.



Plug and Chug vs Problem Solving answers to the same problem.

Alice found chromium in both samples and saw it was in the right place. "But the difference between the samples was interesting," she explained. "The defective sample had much less chromium on average. Also, each line scan showed a different amount, meaning it was not the same everywhere. The good sample showed a consistent thickness and amount in all line scans." About 30 separate line scans were performed on each sample, and the interim report included a statistical analysis. The chromium layer thickness was estimated using peak fitting. No contaminants were observed in the 50-plus images and element maps collected for each sample. Alice's report included observations of the composition of each layer and confirmed that the only issue appeared to be the amount and consistency of chromium present in the defective sample.



Alice explaining the results of EDX line scans.

Act III: But how much is there?

Widget Engineers: "That's great! But can you tell us how much chromium, in µg/m2, was on a particular sample?"

Trent: "A bulk sampling method with a low Limit of Detection (LOD) would be needed. Let me introduce Bob, our expert in analytical chemistry."

Bob (PSL's subject matter expert on analytical chemistry): "We could use Inductively Coupled Optical Emission Spectroscopy (ICP-OES). We would use microwave/acid digestion to completely dissolve the sample, then spray the liquid into a flame. A spectrometer measures the emission line for chromium. We will use a calibration curve to determine the amount of chromium. Dividing the measurement by the sample area would give you the result you are looking for."

Widget Engineer: "That aluminum alloy could have chromium inside, between 0.00 % and 0.10 %."

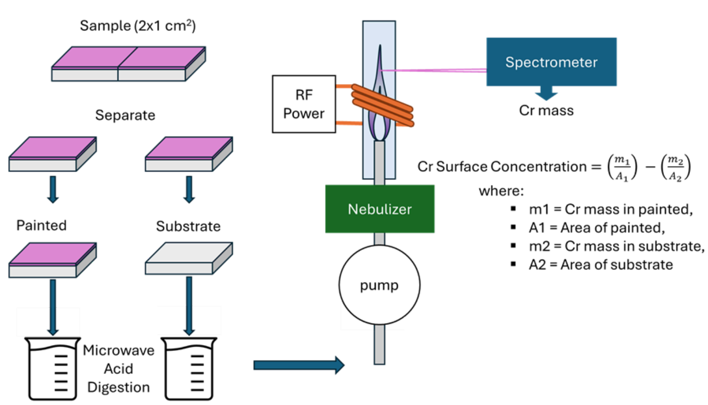
Alice: "I didn't see chromium in the substrate, but I would miss it if it were below 0.1 wt.%."

Bob: "I can see down to ppb levels. Along with digesting a whole sample, we should also digest and measure the aluminum substrate near the sample to ensure we have enough information to get a surface area estimate."

Sample preparation, again, was taken very seriously. A method was developed to trim a two-square-centimeter sample of painted aluminum from a larger section and then split it into two subsamples. One subsample is scraped with a razor until the paint and primer are removed. Then the surface is rinsed with an acidic solution to remove the top layer of aluminum. The area of each sample was determined using a document scanner (calibrated with a NIST traceable resolution chart). After acid digestion of each half, ICP-OES measured chromium for both the substrate aluminum and painted aluminum sub-samples. Finally, the results, in µg/cm2, were reported.

Soon, a standard operating procedure was in place. Widget engineers could have their aluminum stock tested to sort their supply based on surface treatment. Soon, they submitted samples from other aluminum companies to verify alternative suppliers. Finally, they were able to settle with the aluminum company that provided poorly treated aluminum.

Widget Manufacturing used this experience to navigate the world of testing labs and lived happily ever after!



The procedure for determining the surface concentration of chromium.

The Moral of the Story: Different Labs, Different Strengths

Plug-n-Chug Laboratories are fast, efficient, and cost-effective, but should be reserved for routine analyses with established procedures. A good plug-and-chug lab is invaluable when verifying that steel meets ASTM specifications or that your polymer has the correct molecular weight. But ensure the lab you talk to has the industry-specific certifications you need. Ask about sample preparation.

In our story, the Plug-n-chug scientists **should** have asked more questions to avoid wasting time and money.

Fortunately, Widget engineers provided a control and a defective sample for analysis.

Problem-Solving Laboratories represent a research-oriented team that excels when standard methods don't exist or are inadequate. They are aware of the importance of proper sample preparation. They excel at the science that allows them to analyze materials. They sometimes ask an annoying number of questions, but they will also explain the analytical methods they use. The analysts will know their instruments better than anyone and understand sources of uncertainty. They develop custom and often creative approaches. These labs become essential when facing an unknown problem or when initial results don't make sense.

If you make Widgets and you have questions, you need to choose a lab wisely:

Choose efficiency-focused labs when:

- You need routine verification of known properties
- Standard test methods **do** exist for your analysis
- You're dealing with quality control rather than problem-solving

Choose research-oriented labs when:

- Standard methods have failed or given unexpected results
- You're dealing with a new or unusual problem
- The stakes are high enough to justify additional investment
- You need method development rather than routine testing
- You need more than a table of data for a report

Blaise Mibeck is a Senior Scientific Investigator at ***Triclinic Labs*** *(a problem-solving lab) specializing in X-ray and advanced imaging techniques. He has over 20 years of experience developing innovative solutions for complex analytical challenges in research and industrial settings. Illustrator: Teresa Mibeck (****https://www.instagram.com/terra.wakaranai/****)*

Comments

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This is a great way to communicate the difference between two types of labs. Well done Blaise!

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Thanks!

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