

Cleanliness is next to...a successful deposition.

By Dr. David Smith



Introduction

SilcoTek offers the finest inert coatings available. The key: a clean surface. Here are some examples:

Case 1: A customer from the UK was frustrated with the long turnaround time and the frequent necessity for SilcoTek to re-work a particular part, whereas the rest of their order coated fine. Despite heroics by SilcoTek technicians using numerous processes, we could not create a surface that was compatible with our depositions. After appealing to the customer to let us interact directly with their machine shop, we discovered the machine shop was using a cutting fluid that was difficult to remove and it was drying on hot parts before rinsing. A change in the machine shop's process to immediately rinse the fluid from the parts resulted in a 100% pass rate.

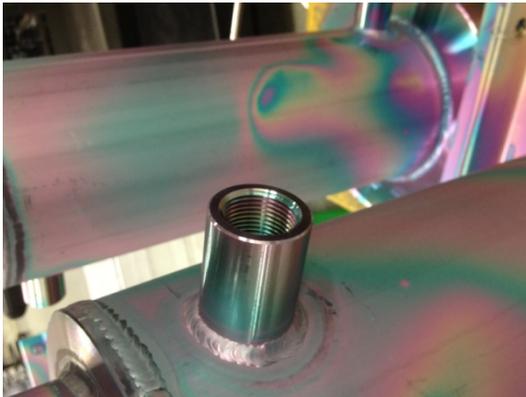
Case 2: Another customer was pickling parts with nitric acid, but the SilcoTek deposition would not satisfy our adherence specifications. After an investigation, we learned that the nitric acid pickling solution was highly contaminated and was leaving residue that could not be removed by SilcoTek cleaning systems. Using clean nitric acid solved the issue.

Case 3: Customer "Q" had good intentions to clean and prepare their parts so that SilcoTek would not have to worry so much about additional surface preparation. Unfortunately, the over-the-counter cleaning solution left a residue that a) SilcoTek's surface preparation process could not effectively remove, and b) resulted in a poor quality deposition, strip, rework (often more than once), delays, high costs and disappointments. After an investigation with the customer, we asked that the part be rinsed with water after machining and nothing else. The result was a 100% pass rate that continues today.



There are literally hundreds of potential surface treatments and cleaning treatments that a customer's part can be subjected to before it is received by SilcoTek for coating. The SilcoTek state-of-the-art, aqueous surface preparation system is proven to effectively prepare over 98% of the parts we receive on a daily basis for deposition. But the few parts with challenging, and often invisible, surface contamination that is not easily removed will result in extended processing times, costs, and possibly global contamination to other parts in the same process.

Therefore, one of the most potent weapons we have to combat the contamination foe is customer communication. When we find a contamination issue, our first line of defense is to contact the customer and learn as much as we can about how the part is handled prior to our receipt of it.



Discussion

How clean is clean?

The most important characteristic for a successful SilcoTek CVD deposition is to have a surface that's free of contamination. For our process to work properly, our deposition materials must be able to diffuse through the metal surface and form a bond with metallic oxides. Contamination on the surface will prevent this important step from occurring. So, how clean is clean? There are several standardized methods that attempt to define surface cleanliness, such as ASTM and SEMI. However, as we have found at SilcoTek, the ultimate test of clean is unfortunately at the back end of

our process, AFTER the deposition has occurred. By then the presence of contamination is obvious, either in the form of a visually imperfect coating (locally and/or throughout several parts) or through poor adhesion of the coating and subsequent flaking loss. When improper adhesion occurs, a part must be stripped of its coating, re-prepared and redeposited. This is a major drain of SilcoTek resources, both in processing time and capacity, in processing costs, and results in delivery time delays. SilcoTek continues to use a considerable amount of resources studying surface compatibilities so that every part enters a deposition chamber ready for unblemished coating. In some cases we can adjust our surface preparation processes to compensate for customer machining practices, but in others we must dig deeper and work as a team with our customer to better understand the surface characteristics of a problem part and find a compatible solution.

There are a few key points to keep in mind when considering the surface quality of your part before sending it to us for coating.

Don't change your current machining / pre-cleaning process without talking to us first!

For most of our customers, we have developed our surface preparation processes to be compatible with the surface you are providing. If you have not been contacted by our Manufacturing, Quality or Research personnel regarding a cleaning issue with your parts *please do not make changes* to how your part is treated before sending it to SilcoTek. However, if you feel that there are cleaning steps in your process that are unnecessary, please contact us and we may be able to work together toward the elimination of extraneous steps in your part handling process. There are many SilcoTek customers that have been able to save time and costs by collaborating with SilcoTek and streamline the steps needed to properly prepare a part for deposition. However, there are also customers who changed their machine shop processes without SilcoTek's knowledge which resulted in pain and suffering for both parties. We encourage all customers to partner with SilcoTek's engineers and scientists to lock-down your specifications and we can in-turn lock-down our processes to deliver a perfectly coated surface on time, every time.



Is the material of construction compatible with SilcoTek processing?

When SilcoTek initially receives your parts, each one is closely inspected for a variety of characteristics to ensure compatibility:

- What is the material(s) of construction?
 - Stainless steels, glass, high performance alloys (nickel-based, titanium), Electropolished stainless steel – these are all standard, approved materials. No problem.

- Carbon steel – it can be coated, but it will flash rust after being cleaned in our standard caustic aqueous cleaning system. A special protectant approved for our process is added to the part after cleaning to prevent flash rust.
- Aluminum – it too can be coated, but cannot run through the standard aqueous caustic cleaning system - we have to use alternative methods. Additionally, aluminum alloys are metallurgically softened by our processing temperatures. This is important to understand for aluminum parts that may undergo mechanical stress during use. For example, aluminum sample cylinders will no longer qualify for the original DOT pressure rating after deposition.
- Pure nickel plate, copper, copper alloys, gold, silver – These and a few other metals are not compatible with our depositions. They will cause inhomogeneous growth and/or poor adhesion of the coating material.
- Teflon, plastics, polymeric materials used for gaskets and O-rings – The temperatures used in our deposition processes will melt, decompose and outgas these materials. As a result, ***they can contaminate an entire deposition chamber and cause an entire batch to be failed and recoated. This is extremely costly in processing time and materials.*** SilcoTek works very hard to ensure the removal of these materials, and we highly appreciate all efforts of our customers to do the same.

Visual inspection is a primary tool for pre-cleaning inspection. We also have an X-ray fluorescence metal detection instrument (Niton XL3t) that will identify the metallic composition in a part. Any part suspected of being a potential “bad actor” will be tested. If we detect a part composed of or plated with a non-compatible material, it will be placed on “hold” and SilcoTek will contact you. The part will then be returned untreated.

Summary

Knowledge is power.

Occasionally, a part arrives at SilcoTek, passes incoming inspection, proceeds without issue through surface preparation and post-cleaning inspection, but after deposition, has obvious issues with contamination blemishes and/or adhesion. SilcoTek first considers the possibility of any problems that could have occurred during surface preparation. For example, is there a chance that not all of our prep fluid was properly removed because of bind holes or threaded areas?

Sometimes this is obvious, and if so, the part will be quickly reprocessed. If there is no obvious internal cause that can be remedied by SilcoTek, our next step is to contact the customer.

When we call you with a deposition issue, there are several questions we may ask. Sometimes a customer does not have the answer right away, or sometimes an answer is not possible due to the proprietary nature of the part, or the data are simply not available. Nevertheless, we will try to obtain as much information as possible in an attempt to drill down to a root cause:

- What cutting oils/fluids were used during its fabrication process?
- Are the cutting oils/fluids allowed to dry on a hot part prior to cleaning?
- How was the part cleaned or treated before shipment to SilcoTek?
- What type of welding/soldering/brazing was used to assemble the part?
- Was the part electrolytically plated?
- Was there a polymeric (e.g. PTFE, polyethylene) coating or internally pressed-in spacer/gasket/packing?

Armed with the right information, SilcoTek will be able to collaborate with the customer and make recommendations and/or process adjustments to solve the issue at hand. It is always the SilcoTek objective to provide the best quality coating every time, on time, with zero disappointments. By building collaborative relationships to overcome technical challenges, we will accomplish that goal.

Learn more about how SilcoTek can improve the performance of your product! Contact us at 814-353-1778 or visit us on the web at **www.SilcoTek.com**.