Application Note C-162

# Scanning the cleanliness of a solid surface

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The cleanliness of a solid surface is an important parameter in a number of applications. However, non-destructive methods available to measure cleanliness are often incompatible with the material under analysis or inconvenient or inaccessible to the operator.

The analysis of inorganic surfaces, for example, is often done with the aid of EDX (Energy Dispersive X-Ray Analysis) Scanning Electron Microscopy. In addition to being expensive and requiring a skilled analyst, samples analyzed with EDX typically require extensive sample prep including the application of a gold coating to the surface of the sample. Organic surfaces are typically analyzed with the aid of FTIR or ATR-FTIR (Attenuated Total Reflectance). In screening samples for contamination it is common to drip a volatile solvent over the surface to be analyzed, concentrate the rinse on a salt plate, and analyze the residue on an FTIR. In addition to the expense and required expertise, additional drawbacks to this approach include multiple time-consuming steps, and exposure to volatile solvents.

Other less-sophisticated analytical techniques for measuring the cleanliness of a solid surface include UV/VIS spectroscopy and photo microscopy. All of these techniques involve a degree of sophistication, time, and expense not readily available in most laboratories. A simple, fast, yet highly sensitive and economical alternative to these techniques is available with the dynamic wettability scanning technology found in the Thermo Scientific CAHN DCA systems. A non-destructive technique that requires no highly trained operators or sophisticated laboratory environment, the DCA technology is easy to apply whenever surface contamination is a problem.

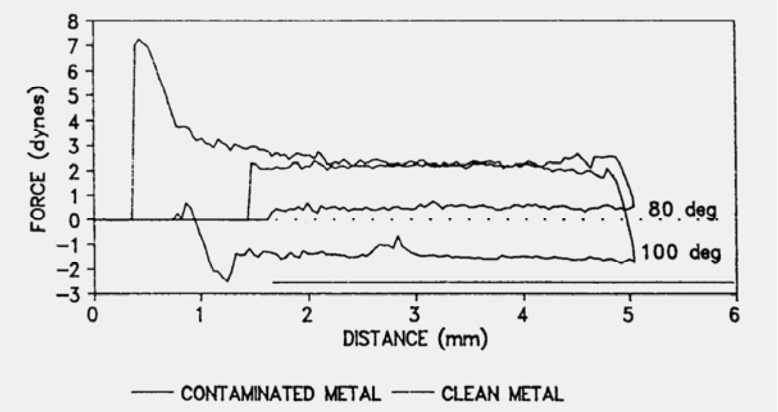


*Figure 1*

**Cleanliness of metal fibers by contact angle hysteresis**

Contact angle hysteresis is a well-studied phenomenon that forms the basis of the DCA surface scanning technology. It is beyond the scope of this communication to review the details of contact angle hysteresis theory, but a quick summary of the principle is needed to illustrate the application in cleanliness evaluations. When a liquid interface is moved along the surface of a solid, it forms a characteristic wetting angle that is indicative of the solid/liquid interaction energy. If the surface of the solid is uniform and homogeneous, the wetting trace will be identical regardless of the scanning direction (advancing or receding meniscus). If, however, there is an element of contamination on the surface of the solid, the wetting curve will highlight this area by recording a change in the wetting forces associated with the existence of the contaminant. This change in wetting force characteristics is known in the literature as contact angle hysteresis.

To apply this concept to the cleanliness evaluation of a surface is straight-forward and simple with most any surface using the DCA technology. After an initial scan of a "clean" sample of the surface to be analyzed in a standard solution (i.e. clean deionized water or appropriate solvent), a "contaminated" surface is scanned in a similar way and the two scans are overlaid to identify the existence of the contamination. The typical analysis can normally be completed in less than 10 minutes, with minimal operator training required.

An example of the application of this concept is illustrated below. A sample of "clean" wire was scanned with deionized water to reveal a hysteresis-free wetting curve (see dotted line in Figure 1). Next, a "contaminated" sample of the same wire material was scanned also with deionized water (smooth curve in Figure 1). Note the significant hysteresis in this curve that is not found in the "clean" sample.

Besides evaluating the hysteresis curve alone as a cleanliness flag of a surface, another approach is to measure the change in surface energy as a function of the cleaning process. This can be especially revealing if the cleaning process modifies the surface by exposing a more or less hydrophobic surface that is different from the nascent surface. For example, when comparing metal surfaces cleaned with a freon cleaner with those cleaned by an alternative process, we found the polarity and total surface energy of the freon cleaned samples to be considerably lower in both respects. When evaluating the “adhesive match“ between a substrate cleaned by one method as compared with another, surface energy and polarity matching is often useful and predictive.

With the emphasis on alternative cleaning methods brought on by global bans of CFC-containing solvents, the search for alternative cleaners has become an international priority and the DCA has played a key role in helping to identify alternative solutions.

For more information on cleanliness evaluations using the Thermo Scientific CAHN DCA system, contact Thermo Scientific CAHN or a representative.

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