Identification and Evaluation of Coatings Using Hand-held FTIR

Application Note

Authors

Shannon M. Richard,
Pik Leung Tang PhD

Agilent Technologies,
Connecticut, USA

Introduction

Coatings serve a variety of purposes. Some of those are purely aesthetic in nature, but the majority of coatings are added for their physical properties whether it is to protect by inhibiting oxidation or wear due to weathering of the product, or to enable two materials to be bonded that ordinarily would not bond well as is the case for a primer coating. These protective coatings are typically multi-layered industrial coatings that consist of a process involving the substrate materials, pre-treatment of the substrate, primer/adhesive application and a topcoat or film laminate to seal the coating. In order to ensure that the coating has been applied and cured effectively, process engineers have had to rely on a standard waiting time before proceeding to the next process in manufacturing. However, times could vary depending on conditions surrounding the process causing the wait period to maximize to ensure that the product was complete in order for the process to move forward.

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FTIR has been used in the coating process in the past, but mainly for research and development applications. This was due to fact that the instruments had to be maintained in a laboratory environment and that small samples or pieces of large samples would have to be brought to the lab and could not be measured at the point of concern or production. Agilent's hand-held portable FTIR systems with innovative sampling technologies have taken the FTIR out of the lab and enabled its use on the production floor or wherever the sample happens to be operational. This is essential for measurements that need to be made at the point of concern or for samples that are just too large to be able to measure in a laboratory setting. This can be critical, since not all samples allow for taking a small enough piece to the laboratory for measurement when issues or concerns arise.

Examples using FTIR technology

The identification of coatings on materials can prove to be a cumbersome task, especially when samples look identical to the eye. At times, it is important to identify various materials in real time. Coatings are an excellent example of the materials that can be identified as most coatings, primers and bonding materials are made of organic compounds. In Figure 1, we show an example of using the Agilent 4100 ExoScan FTIR with the Diffuse Reflectance sampling interface to determine the difference between Polyvinyl Chloride (PVC), Polyurethane (PU), and Polyvinylidene Fluoride (PVDF). The spectra show that these are easily distinguishable from one another.

In this particular instance, the PVDF coating is used for situations where weather, UV and solvent resistance are critical to the end product's offering. It is important to note that it is also the most expensive of the three coatings. Choosing the wrong coating for the appropriate application or situation by merely viewing the visually identical samples could result in choosing the wrong coating for the customer. Depending on the usage, it could cause the substrate to weather exponentially and lead to failure.

In turn, choosing a sample that has PVDF when it is not required costs the supplier due to the expensive nature of this coating versus the others.

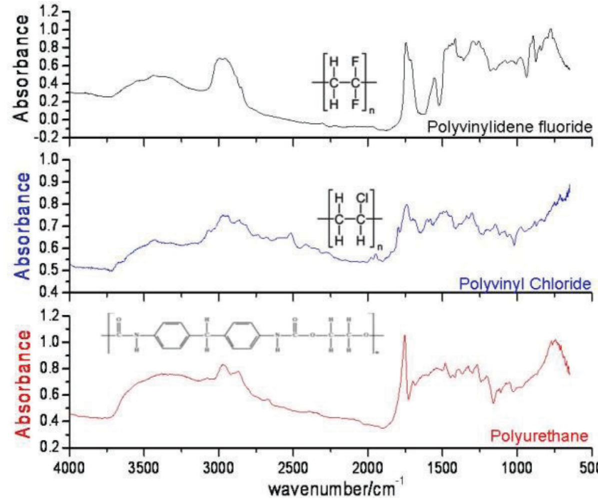

Figure 1. Diffuse FTIR Spectra of Polyvinylidene Fluoride, Polyvinyl Chloride, and Polyurethane

Another instance where FTIR can prove to be beneficial is during the cure process for coatings. Determining whether the cure process has completed or what the optimal cure rate and temperature should be can be a tricky task. Using the ExoScan, also with the Diffuse Reflectance sampling interface, a two part epoxy primer cure profile was established. The cure times ranged from 0 to 308 minutes at specified intervals. The sample was cured at room temperature to establish baseline data. Figure 2 shows representative data and specific regions of the spectra where changes are evident. These changes can be used to establish the level of cure of the epoxy/hardener mixture. Establishing cure level versus curing time is easily done and can be used to set pass/fail criteria for cure completion when sampling the material.

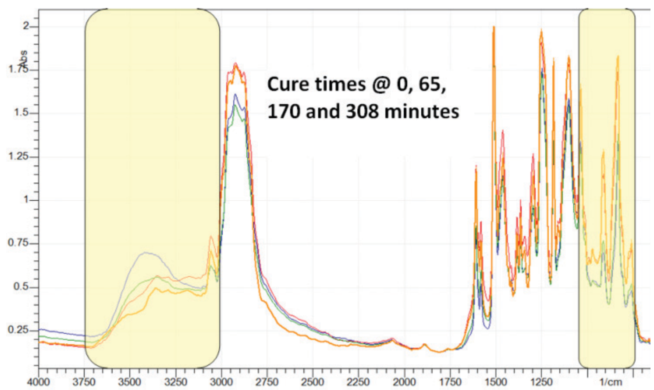

Figure 2. Room temperature cure of Epoxy/Hardener coating at 0 (orange), 65 (red), 170 (green) and 308 (blue) minutes. Highlighted areas show changes as the mixture cures and can be used to measure cure level directly once a correlation has been set up

Examples using FTIR technology

These examples show that FTIR can easily be used for simply identifying coatings as well as the more complicated task of evaluating cure completion. Hand-held FTIR has also been used to determine contamination on the actual coating, coating thicknesses, anodization thickness levels and even accelerated weathering studies to determine long term performance of high-end coatings. These other examples show the versatility of Agilent's portable 4100 Exoscan FTIR in the coatings industry and the diversity applicable samples that are expanding each day.

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