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What a new ASTM standard for plastic film thickness and variability means for converters

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Editor's Note: *"D8136 – Test Method for Determining Plastic Film Thickness and Thickness Variability Using a Non-Contact Capacitance Thickness Gauge" has been approved and is currently available for purchase from ASTM.* https://www.astm.org/Standards/D8136.htm

Abstract

A new ASTM standard can help converters improve process speed and performance, select better suppliers and avoid running plastic film that is outside of their specification. "D8136 – Test Method for Determining Plastic Film Thickness and Thickness Variability Using a Non-Contact Capacitance Thickness Gauge" standardizes the common industry practice of profiling film. It is a NIST-traceable way to determine a film specimen's average thickness and thickness variability using a method that has excellent repeatability and reproducibility. Standardizing this test method will allow converters to distinguish between suppliers based on good and comparable data. This paper describes the method, the device, a case study and the broader impact for converters.

Introduction

Plastic-film thickness and variability have real implications for many converters, and the new "D8136 – Test Method for Determining Plastic Film Thickness and Thickness Variability using a Non-Contact Capacitance Thickness Gauge (NCCTG)" can help improve quality, customer/supplier relationships and converting processes.

Many converters are using thinner and thinner films as companies look to reduce material usage, go green and cut costs. As films get thinner, they become more difficult to measure using contacting methods. For example, many producers use micrometers that are precise to +/-1 micron, and this is +/-8% of the thickness of a 12-micron film. If the converter were buying a 12-micron film with +/-5% variability, it is easy to see that a contacting method is not going to be sufficient for measuring the average thickness or variability of that material. The act of contacting the film can compress the material and create bias in the reading as well, skewing the average thickness reading of the material.

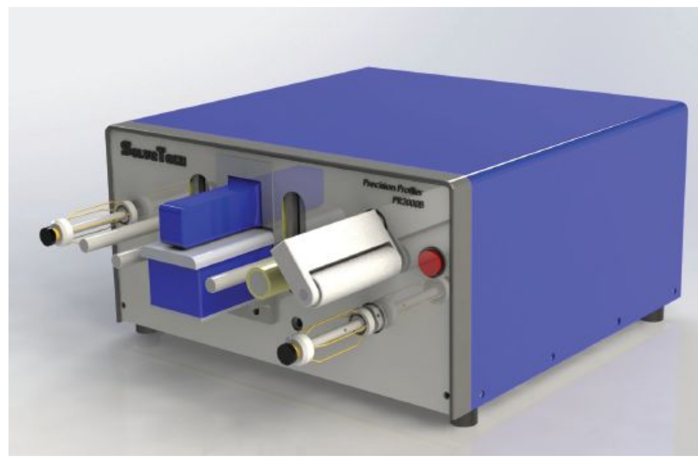

FIGURE 1. *Non-contact capacitance thickness gauge (NCCTG) profiler*

The film manufacturing and downstream purchasing and converting industries now require more precision and less bias, and the standard seeks to satisfy this need.

Contact vs. Non-contact: A repeatability and reproducibility (R&R) study

This firm conducted an R&R study comparing a contact micrometer to this firm's profiler (this unit combines the NCCTG with a drive mechanism, software and material handling to measure multiple points on a film) to quantify the difference in performance (see Figure 1). A strip of 20-micron-thick blown film was measured in 10 locations by three different operators conducting two trials each. The operators could not see the reading they were getting, and it was recorded by a computer. The data from the test are shown in Table 1.

Good R&R is under 10%, with an upper limit for acceptability at 30%. The results were an R&R of 69% for the contact device vs. an R&R of 3% for the non-contact device. (Similar R&R results on the profiler have been independently confirmed by several customers). Therefore, the contact method is not sufficient to look at the variability of the film in a meaningful way because it is well above the 30% limit. The new method now gives converters a method that produces meaningful data they can use to make good decisions.

TABLE 1. *Readings taken with a non-contact device and a contact micrometer for comparing repeatability and reproducibility*

	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6	Location 7	Location 8	Location 9	Location 10
SolveTech PR2000- Resolution of 0.001 mils										
Operator 1- Rob										
Trial 1	0.747	0.895	0.848	0.785	0.649	0.760	0.929	0.771	0.724	0.803
Trail 2	0.749	0.895	0.846	0.788	0.651	0.757	0.935	0.765	0.726	0.797
Operator 2- AJ										
Trial 1	0.748	0.894	0.849	0.784	0.658	0.761	0.936	0.771	0.727	0.804
Trail 2	0.750	0.894	0.848	0.783	0.653	0.760	0.928	0.771	0.719	0.804
Operator 3- Ping										
Trial 1	0.745	0.902	0.846	0.782	0.651	0.758	0.931	0.769	0.725	0.802
Trail 2	0.742	0.899	0.849	0.786	0.648	0.755	0.931	0.765	0.727	0.798

	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6	Location 7	Location 8	Location 9	Location 10
Micrometer-Resolution of 0.050 mils										
Operator 1- Rob										
Trial 1	0.650	0.850	0.950	0.750	0.650	0.800	0.950	0.800	0.750	0.800
Trail 2	0.750	1.000	0.750	**0.750**	0.800	0.800	0.900	0.750	0.850	1.100
Operator 2- AJ										
Trial 1	0.850	1.000	0.800	0.700	0.700	0.800	0.900	0.800	0.800	0.800
Trail 2	0.800	0.900	1.100	0.750	0.800	0.800	0.950	0.800	0.800	0.900
Operator 3- Ping										
Trial 1	0.650	1.050	0.850	0.650	0.600	0.700	0.800	0.750	0.750	0.750
Trail 2	0.650	1.050	0.900	0.700	0.750	0.700	0.900	0.750	0.750	1.150

What is profiling, and what makes a good profiler?

Profiling film is necessary because measuring one point on the film is not enough to determine the average thickness or to determine variability.

To profile a film, we cut a strip of film off of the end of a roll and run it through a profiler (see Figure 2). The profiler takes readings as it pulls the strip through a measurement head, and it produces a graph and thickness statistics. This indicates the patterns and amplitude of variability that you will see in the material you are converting, as well as the average thickness of the sample.

The procedure is quick and easy, taking about 60 seconds, while collecting a large amount of data. It measures the material every 0.125 in. using a 0.125-in. footprint, which results in every area on the strip being measured.

When determining what makes a good profiler, you first want to look for repeatable precision. To easily visualize this, we can overlay the graphs of two back-to-back runs of the same sample (see Figure 3).

A second critical performance factor is bias, meaning that it accurately predicts the actual thickness of the material. This firm has conducted multiple trials on the bias performance and finds the instrument is typically accurate to +/-0.5%.

Profiling can be performed by the material producer as part of its QA procedure, by the converter during incoming product inspection or by both parties.

Case study

A film producer was selling material to a film converter that was one of the film producer's largest customers. Due to issues with the thickness of the film, the converter was rejecting about 10% to 15% of the material. The converter and producer became very frustrated because, over a six-month period, this issue had cost the converter approximately $100,000, and it was also costing the film producer $15,000 to $20,000 per month. Combined, the costs added up to more than $200,000 between the two parties.

Both the supplier and the converter had profilers to measure film thickness and variability. Film variability was important to them as they saw issues with the film sealing, and bags that had high variability also were failing bag tests when they loaded the bags with 30 lbs. The thin side of the bag would break, failing the test. They called this firm about one year ago to see if a solution could be found to fix their average thickness problem using their profilers.

To solve the problem, we used the methods in the new ASTM standard. We requested samples of the material, calibrated an instrument here using their material and then created calibration frames that are used as a calibration reference. This calibration of the instrument used the NIST-traceable calibration that is the preferred method in the standard. Using the calibration frames, the buyer and the seller matched their measurement instruments to each other so there was no longer a discrepancy. Along with the instruments matching each other, they also were accurately calibrated to the correct answer according to gauge by weight. Now the supplier checks the material while producing it and before it ever leaves the site. When the converter receives it, the converter checks it as well and gets the same answer.

One year later, the relationship between the film supplier and converter has never been better. Rejections have been reduced from 10% to 15% to 0.5%, resulting in a huge cost savings,

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FIGURE 2. *A user cuts a strip off of the end of a roll, runs it through the profiler and gets thickness data quickly.*

as well as making both operations run more smoothly.

The converter writes monthly reports on its suppliers and has now only praise for the film producer. The converter plans on requesting that all of its suppliers comply with the new ASTM standard because it has been such a help to the operation.

Understanding the standard

D6988 is the current ASTM standard for measuring plastic film using a contact micrometer. It mentions the use of a non-contact device, but it does not go into detail on non-contact devices. There were many issues with the method, with the biggest being that the standard cannot make a precision or bias statement.

The new D8136 standard creates a standard way to measure the thickness of film that will have a precision and bias statement. There also is a 10x increase in the precision of the instrument, which is required for thinner films.

The new standard defines the requirements for the measurement device and how to profile a film specimen. It also lays out four different calibration options. The calibration of the instrument is one of the biggest impacts the standard will have because of all of the issues surrounding accurately measuring thin films.

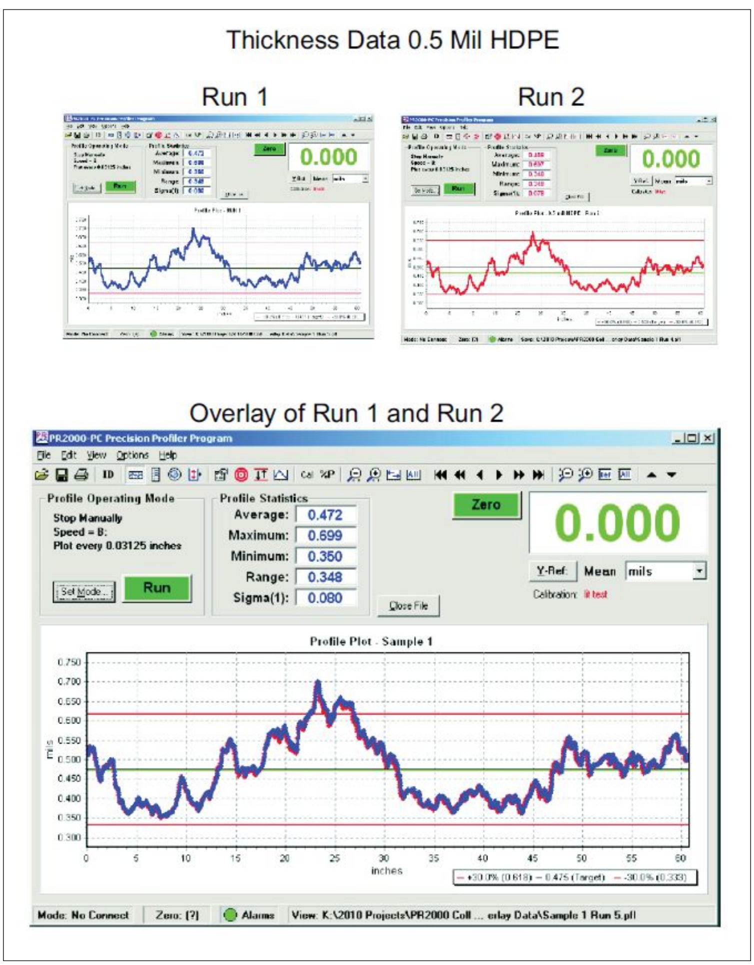

FIGURE 3. *Two back-to-back runs on a film sample are overlaid to demonstrate repeatability.*

Impact on converters

From what we have seen, it is fairly common for there to be disagreements about the thickness of film a converter has purchased. To quote another film producer, “Everyone cheats on gauge.” The film producer from the case study cited here mentioned that he also sees competitors trying to undercut him by running on the low end of the specification. For example, if the spec is 2 mils (+/-10%), they may consistently provide 1.8 mils. While technically in specification, this is not the intent of the specification. In the past, there have been lawsuits and many damaged business relationships over this issue. The new standard seeks to solve this problem and keep the entire industry honest. It defines film thickness using a NIST-traceable calibration and uses a device with a precision of +/-0.1 microns.

In addition to providing an accurate average thickness reading, it provides converters with meaningful variability data. These data allow them to see quantifiable quality differences between suppliers. This helps move the film industry away from being cost-driven to being more performance-driven. Now, buyers can compare the variability of film and, before it is shipped to a converter, the film can be checked using this new standard to verify it will perform as intended.

Tighter specifications and more consistent base materials can lead to improvements in converting processes. More uniform film tends to be more stable in converting processes, which may improve the reliability and speed of the process. One film producer mentioned that the data helps him troubleshoot converting issues, such as failing seals, more quickly. The variability data can be analyzed, and the troubleshooter can see if the problem is in the film or if the equipment should be the focus.

Other converters have previously instituted the standard (before it was a standard) out of necessity. One customer found that if the profile did not meet certain variability requirements, its flexographic-printing process would not operate properly. The customer required that its supplier meet a variability requirement per the profiler and wrote this into the procurement agreement.

Conclusion

The new ASTM standard represents an order of magnitude improvement in measuring the average thickness and thickness variability of plastic film, and this will have a valuable impact for film converters. It can resolve disputes about average thickness and help converters identify quality suppliers based on good data. It now offers buyers and sellers of film a test method for characterizing film variability, and this will help the entire industry move toward producing higher-quality products and help converters innovate and operate more efficiently. ■

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