

Revolutionising Coil Coating – Real-Time Online Measurement of Coating Thickness that Works



Early prototype of Wolf DFM1 Dry Film Thickness Monitor showing CO2 laser at the top and the laser sensor in the foreground.

Wolf Innovation is a new name soon to be well known across the global coil coating industry, having developed an exciting new technology package in the field of on-line real time non-contact coating thickness measurement. The system is surprisingly simple and is founded on logical concepts that provide reliable, easy to use, and largely calibration free wet and dry film thickness measurement. Wet film build is measured at the coater and dry film thickness is measured after the exit end accumulator and before the inspection station. The system enables elimination of test strips prior to a production run and it allows fine tuning of dry film build to very tight tolerances as soon as the cured strip reaches the Dry Film Monitor. There are three major components to the system known as Wolf CCS1. These are WFM1 – the wet film monitor, DFM1 – the dry film monitor, and PVS1 – the paint volume solids instrument.

How the System is Used in Practice

Wolf Innovation aims is to achieve absolutely reliable and very tight control of coating thickness throughout coil coating without the use of test strips, wet film wheel gauges, or any other approach that diminishes production line efficiency or yield. To do this it is necessary to be able to start painting at the right thickness from the start of every new color, coil, or production run. To achieve this we have developed WFM1 wet film monitor which measures film build on the coater during coater set-up. This is a quick measurement taking about 5 seconds on each side of the coater. Once the coater is adjusted to the correct film build the system typically enables you to commence painting within plus or minus 0.7

um of the target dry film thickness. With this system your target should be thought of in terms of being a specific minimum film thickness rather than a target film thickness range.

Having achieved that the next goal is to verify the actual dry film thickness and further tighten the film build specification. As the coating is cured and product reaches DFM1, the dry film monitor, the coating thickness profile across the entire strip is measured. This takes about 2-3 seconds, and the coater can then be fine tuned. You will be able to watch the film build change as you adjust the coater once the strip with the adjusted film build reaches DFM1. You can also watch the change instantly with WFM1 – the wet film monitor in the coater room. Film build is checked during early production until the dry film build is within 0.5 um, or better, of your target average or minimum film build. Ongoing monitoring of dry build then ensures you stay at the target without deviation and without risk.

The final element of the system is PVS1 - the paint volume solids instrument. This is an essential component needed to predict conversion of wet film build to dry film build, that is, it provides an important input to WFM1. It also allows you to accurately calculate the volume of paint needed to complete a production order, and it enables you to monitor the batch to batch and supplier to supplier volume solids characteristics of paint. After all, paint is one of the most significant expenses in the coil coating process.

What are the Benefits

In a nutshell, Wolf CCS1 provides tight efficient control of film build needed to avoid any paint wastage or excess, while ensuring that under specification product is a thing of the past. Doing away with test strips eliminates wasted metal strip and frees up production time. Test strips are time consuming and inefficient, and wet film wheels leave marks on the strip that cannot then be used. Test strips are also used to achieve colour consistency, however correct cure, correct film build, and monitoring paint quality should significantly reduce or even eliminate colour matching issues to negligible levels.

However we don't all use test strips and many of us believe that our control of the coater is pretty good. We may rely on wet film wheels to measure wet film build at the start of production to ensure that product is within specification. However consider that the paint volume solids (PVS) property of topcoats may vary by as much as plus or minus 4-5% from a nominal value – we have actually measured that level of variation under real industrial conditions. 2% variation in PVS results in a 5% variation in film thickness or a 5 % variation in cover at the same dry film thickness. That is, at nominal 43% volume solids the actual dry film thickness may vary by up to +/- 2.5 um due to topcoat PVS variability. This can be readily eliminated by measuring the PVS value of the paint that you are about to use prior to the commencement of production. It's a test that takes a few seconds to set up and displays the results in a under 3 minutes.

Table – Difference between actual and predicted thickness based on PVS1 measurements - polyesters

Supplier	Colour	Type	Gloss	Paint Volume Solids %	Predicted Thickness	Actual Thickness	Difference
					um	um	um
A	Off White	Polyester	25	44.9%	22.0	22.0	0.01
B	Attic	Polyester	25	41.7%	20.4	20.5	0.06
A	Armour Grey	Polyester	25	42.5%	20.8	21.0	0.17
A	Ebony	Polyester	25	38.9%	19.1	18.8	0.30
B	Smooth Cream	Polyester	80	48.4%	23.7	23.6	-0.17
B	Rivergum	Polyester	25	42.4%	20.8	21.0	0.22

Having commenced painting without the use of a test strip it may take 5 to 10 minutes or longer to verify film build from a sample cut from the coil and then adjust film thickness on line. Having done that it is still not possible to be absolutely certain about the actual film build for the rest of that production run. Line operators usual practice is to rely on the stability of the coating system and consistency of the paint during any prolonged or even short period of production. Even fully instrumented coating heads can still be fooled by inconsistency of paint volume solids. The risks are either paint wastage or quality complaints. The above figures illustrate the benefits and savings possible from even just the paint volume solids instrument.

How It Works

The system uses off the shelf high precision sensors to make the fundamental measurements which are then converted to meaningful film thickness results via sophisticated algorithms and software. More detail is provided below.

DFM1 – Dry Film Monitor

The measurement of dry film thickness uses a CO2 ablation laser to blast tiny holes 180 um wide barely visible to the eye, through the paint layer without touching the underlying metallic substrate.

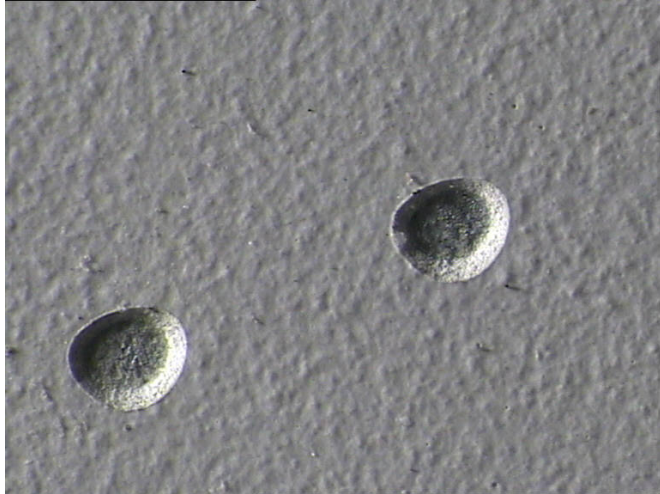


Figure – enlarged view of laser pits in polyester paint – thick coatings are not an issue

These pits in the paint are then measured with a laser sensor at a rate of 20-30 kHz or more if needed to a resolution of 0.1 um. A minimum sequence of about 20 of these measurements is needed to get a statistical picture of the film build in an area of strip since each measurement represents only one tiny point of the coated strip. Whenever the strip is stopped, that is, in order to cut or remove a coil from the exit end of the line the DFM1 monitor can quickly scan right across the strip and take over 1000 measurements if needed, to provide a complete thickness profile across the strip. This can be done in about 2 to 3 seconds. Measurements can also be taken at any time or at any position across the strip during coating.

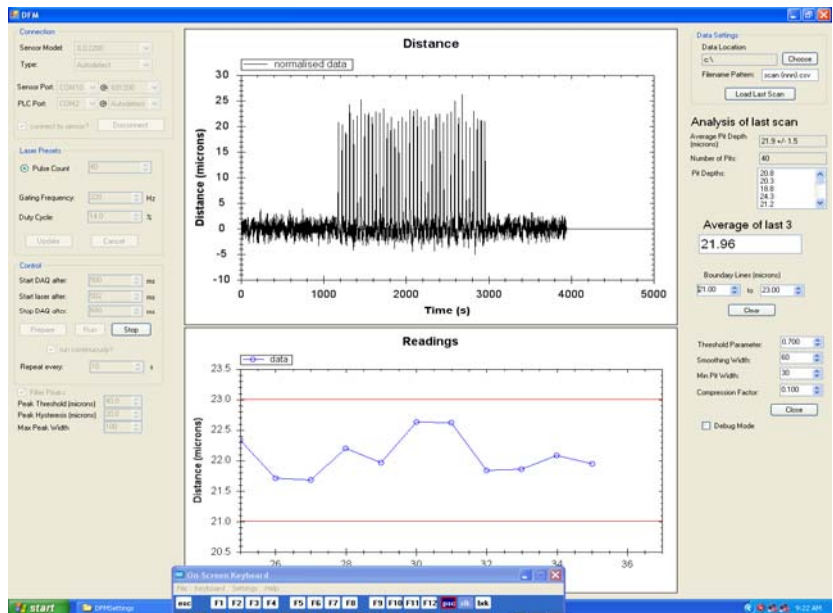
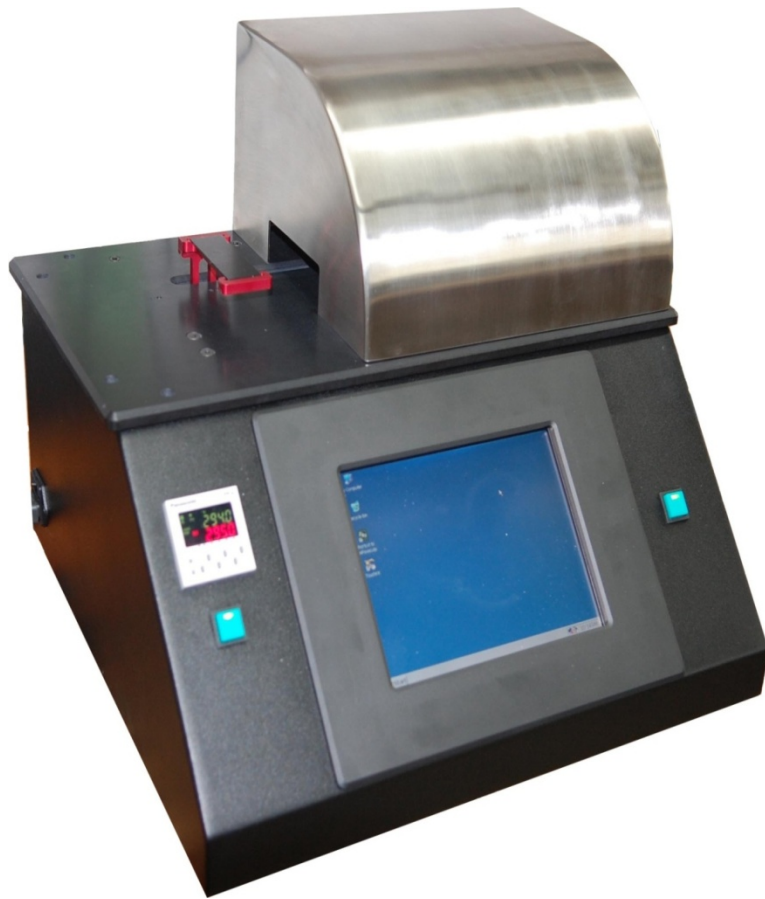


Figure –Software interface for DFM1 showing a reading for 40 pits at the top of the image, and the results of 11 successive measurements (40 pits each) at the bottom of the image

Wet film measurements are a little bit trickier. WFM1 measures the wet film build on a roll of the coater. It does this with an intrinsically safe sensor that uses a 4W beam of white light to measure the surface. We have developed a methodology that measures and remembers the behavior, position, roughness, and movement of the coating roll being measured without paint on its surface and this data is used as reference data. Data from measurements of the roll with paint on its surface is used with the reference data to extract the wet film build. A coating model that uses roll speeds, line speed, and coating transfer efficiency translates the wet film thickness into a predicted dry film build. This is a simplified explanation of the principle of operation, which is somewhat more complex in reality.

PVS1 – Paint Weight Solids Instrument



Paint volume solids is measured separately with an off line instrument shown above. One drop of paint is placed on a sample holder and this is immediately scanned with a precision sensor. Solvent evaporation losses are taken into account during the very short phase of sample preparation. The profile of the paint sample is translated into an equivalent wet film volume, and the paint sample is transferred to a small oven which cures the paint to the same degree as would occur on line. After curing the paint sample is cooled and rescanned to extract an equivalent dry film volume. PVS equals the dry volume divided by the wet volume.

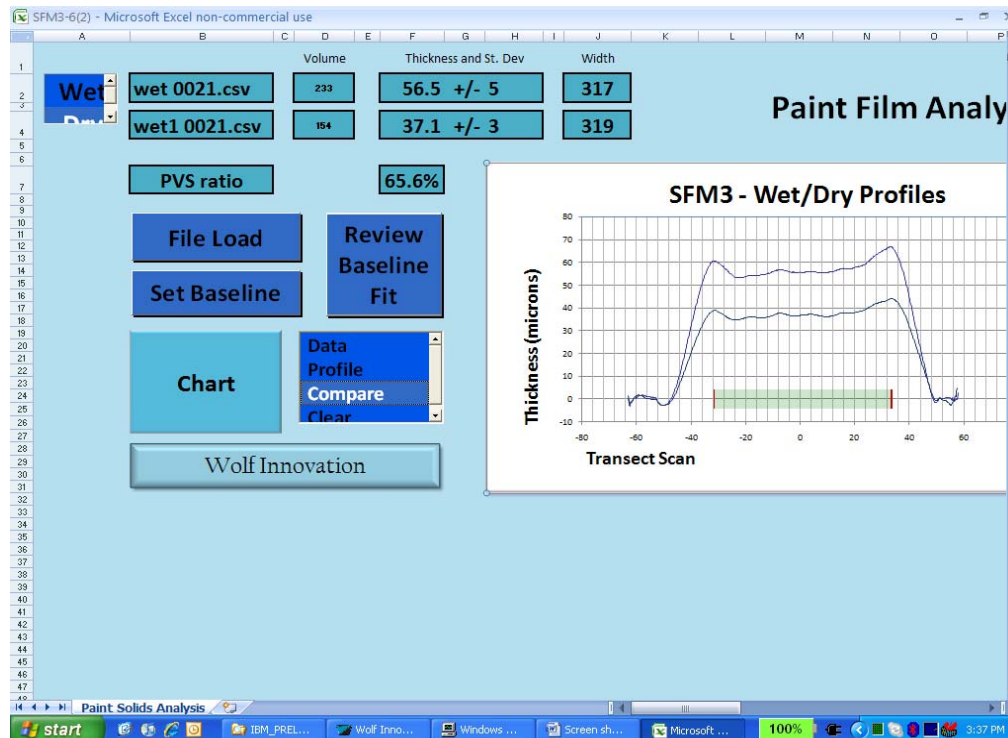


Figure – sample scans of wet and dry profiles of a prepared drop of paint

The principle for the instrument is fundamentally simple and sound. Measurement of PVS is typically to an accuracy of +/- 0.2%. Testing is simple and fast. Results are available in 3 minutes – other methods for measuring PVS take 2 or more hours to complete and are usually not reliable.

Paint weight solids (PWS) is sometimes mistaken to be the same property as paint volume solids. Whilst both properties provide a measure of the amount of solvent in paint only PVS can be used to predict dry film build and provide other useful information that relates to coil coating. The only real use of PWS is as a measure of batch to batch consistency of paint; however PWS provides a better, faster, more accurate measure for the same thing.

In Summary

Wolf Innovations coating control system Wolf CCS1 represents new leading edge technology for the coil coating industry and promises to improve your control of paint coating thickness in a fast, reliable and efficient manner to maximize the efficiency of your coil coating process.

Special introductory deals are available for a limited time during early uptake of this technology and to help through these tough economic times. Contact Bronx International (Australia) at www.bronxinternational.com DJH Designs in Canada, www.djh.com or Wolf Innovation in Australia – www.wolfinnovation.com Imperial unit versions of this overview are available on request from Wolf Innovation.