

Understanding Surface Profile with the Elcometer 224 Digital Surface Profile Gauge

In the industrial and protective coatings industry, metal surfaces are blasted not only to remove corrosion or old coatings, but to generate a surface profile prior to re-painting. In some industries a surface profile is achieved through chemical etching or mechanical abrasion. But, regardless of the method, the surface profile increases the surface area of the metal - and it is this increased surface area which provides a key for the coating to adhere or stick to.

If you apply paint to a smooth, mirror finished piece of steel, you'll find it is very easy to scrape off – even with your finger nail. The same paint applied to a blasted piece of steel is another matter entirely.

Imagine this piece of steel is a piece of land, and you are going to walk in a straight line from one side to the other, from A to B. If it's completely flat land, like a polished surface, the distance you'll walk will be considerably less, than if you were to walk from A to B across mountainous land. That's essentially what a blasted profile is – a mountain range of peaks and valleys of varying sizes on the surface. The steel panel is still the same size, but the surface area within it has increased – and in all directions. It is this increased surface area that ensures that a coating adheres (or sticks) to the substrate.

Surface profile should not be confused with roughness. Surface profile is a measurement of the peak-to-valley height. Surface roughness, on the other hand, is the combined measurements of the surface profile and the frequency of the peaks across a linear length (also known as the peak count). Surface roughness is measured using a stylus instrument, which follows a similar linear path as our A to B example, only over a shorter distance.

So, now that we have defined surface profile as the peak-to-valley height, why is it important for the coatings industry to measure it?

Quite simply, to avoid corrosion. Corrosion is typically caused when three things come together – a ferrous material (in our case the steel substrate – although it is worth noting that non-ferrous materials can also corrode), oxygen (from the air) and moisture. If you can remove just one of the 3 elements, corrosion (or more precisely aerobic corrosion) simply cannot happen. Applying a coating to the steel provides a barrier between the steel and both the air and moisture, preventing corrosion. So if the coating is damaged, or simply rolls off the surface due to poor adhesion, then the steel will rust, corrode, and in time weaken the structure. Not exactly ideal if you are coating a bridge for example.

Now, whilst we know that the surface profile increases the surface area, and through this the adhesive properties of the coating, how do we know what surface profile is required?

Well, quite simply, this is specified by the coating manufacturer or the coating specification agreed to by all parties, and is directly related to the specified dry film coating thickness being applied.

Typically the surface profile specified is the peak-to-valley height in either microns or mils. The coating is also specified in either microns or mils, as a dry film thickness. The key here is that the required coating thickness is applied to both the valleys and the peaks, otherwise you get rust spots.

So, if the profile is too high, the amount of paint used to cover the peaks is significantly more, otherwise there are thin areas of cover – resulting in poor protective properties, leading to rust rash and early failure.

If the profile is too low, then the coating applied can be too thick, leading to possible cracking of the coating whilst it dries (or cures), resulting in corrosion and pinholes. Not to mention that there may also be an insufficient surface area to provide a suitable key for the coating - leading to poor adhesion and premature coating failures.

So how do we measure surface profile?

There are a number of methods for measuring surface profile, and they all work in different ways.

Surface Comparators are flat, metal plates, which contain a number of reference surface profiles. The comparator is placed on the surface, which is compared with the reference profiles through either sight or touch. The profile is then determined and recorded. While this is a quick assessment of the surface profile, it's a highly subjective method of measurement, as it can come down to the opinion of one person over another.

A widely used, and less subjective alternative is the Replica Tape method.

A tape with a compressible foam pad is applied to the surface, and rubbed with a burnishing tool. By rubbing the tape into the surface, the foam is pushed down, creating an inverse or mirror image of the profile. The tape is then removed and measured using a thickness gauge, such as the Elcometer 124 gauge. The replica tape method provides a peak-to-valley height measurement of the profile.

Unfortunately this method has a low stated accuracy, and the test itself is quite time consuming – especially for some profile ranges where you need to test the same area with multiple grades of tape and take the average.

A faster, more accurate, and repeatable method for measuring surface profile is the new Elcometer 224 Digital Surface Profile Gauge.

The Elcometer 224 is a needle depth gauge, which is very easy to use. Simply zero the gauge on glass, and, when the gauge is placed on the surface, a spring mounted needle measures the depth of the profile from the peaks of the profile at that particular point. As the measurement point is not necessarily at the very bottom of the valley, and could be somewhere on the slope so to speak, the user takes either 5 or 10 individual measurements, after which the gauge then provides a reading. The reading displayed is user selectable, and can either be the more common average peak-to-valley height, or the maximum height.

With the ability to measure profiles up to 500 microns (20 mils), on flat or curved surfaces, the Elcometer 224 Digital Surface Profile Gauge provides repeatable and reproducible measurements [accurate to $\pm 5\%$]; can store each reading into memory [150,000 readings in 2,500 batches] – and can instantly transfer them to your PC or mobile device using ElcoMaster; our free, easy-to-use software application, generating professional inspection reports, instantly.

What's more, the new Elcometer 224's measurement modes, make sure that you can collect and record the data you need in accordance with your relevant test method, or standard.

As I've already mentioned, taking just one reading on a blasted surface will not be representative of the entire surface profile, as the needle could rest in a valley or on any part of the slope. That is why you need to take a number of readings over a small area to get a statistically valid measurement. That's why most test methods or standards recommend you take multiple readings in one location; some say ten [ASTM 4417-B], others say five [SANS 5772]; and again depending on the standard you should record either the maximum or average of these readings.

The new Elcometer 224 Digital Surface Profile Gauge can store either the average or maximum peak to valley height reading into memory. Alternatively, if you want to store every value, simply select the gauge's Immediate mode.

So, no matter what number of readings you are required to take, and whether you are required to record the average of the averages, or the average of the maximums; the new Elcometer 224 makes it easy to record the results.

The gauge can also calculate and display statistics live, as you take readings; including the average, low and high values, standard deviation, and coefficient of variation to name a few.

Once you have taken the readings, you now need to decide what to do with them. One way is to write them down individually as you take them, and type them into a spreadsheet later. Alternatively, connect the Elcometer 224 to your mobile device via Bluetooth, and either transfer the readings from memory, or transfer each reading into the ElcoMaster App, live as you take them. Either way, once the inspection is complete, you can instantly generate and send the inspection report, anywhere in the world, via email or the cloud.

So, when you are measuring surface profile, let the Elcometer 224 and ElcoMaster App, take all the effort.

For more information and training on the Elcometer 224 Digital Surface Profile Gauge, click on one of the links on-screen, or visit Elcometer.com. And please, don't forget to subscribe to the Elcometer Channel to be notified of any new videos.