Tony Burrows, Managing Director, Rhopoint Instruments, discusses the development of a goniophotometer, which can measure reflection profiles

Enhanced surface quality measurement

It has been recognised that a highly glossy, smooth finish is synonymous with high specification, high quality products. There are many examples where a quality finish is prevalent; highly polished cars with sleek wet-look paint, towering luxury yachts with acres of glossy coatings, piano black plastics and wood effects on the highest quality consumer electronics and highly polished wood lacquers on quality furniture.

The glossmeter is the most widely used apparatus for assessing the 'shininess' of surface finishes; its use is common throughout product manufacturing, from raw material suppliers, coating manufacturers through applicators and end-user quality control.

The limitation of gloss measurement, however, is that it does not quantify common coating faults that reduce appearance quality. Coating related effects such as orange peel and haze are apparent to the human eye but are not directly measured by the glossmeter.

Over the past 50 years several additional parameters have been developed to measure these effects but due to poor measurement on non-flat surfaces or high cost of instrumentation their usage throughout general industry has been minimal.

HIGH DEFINITION

Rhopoint Instruments has developed the IQ, a 20/60/85° angle glossmeter with a high definition goniophotometer, which replaces the usual 20° glossmeter optics.

Rather than the simple quantification of reflected light made by traditional gloss optics, the goniophotometer measures a detailed profile of reflection.

The data from this profile are processed using the angular tolerances relevant to each measurement parameter. The IQ then calculates 20°/60 and 85° gloss, Haze, Log Haze, Rspec and RIQ/DOI, measurement and display is completed in approximately one second. These additional values allow the user to assess more the reflective quality of the measured sample.

The measurement technology employed by the IQ compensates for non-flat surfaces, giving more repeatable readings than previous instruments. Measuring these parameters with a single goniophotometric sensor means instrument costs have been significantly reduced and the product is priced competitively with standard glossmeters.

ORANGE PEEL

A significant barrier to achieving a perfect finish is a visual effect known as 'orange peel'.

If incorrectly formulated or badly applied, high gloss coatings have a strong tendency to form a surface with a bumpy texture that closely resembles the skin of an orange – hence the term 'orange peel'.

The human eye is exceptionally sensitive to texture effects on highly glossed surfaces so effects such as orange peel detract from the quality appearance of any product, especially when present in abundance.

The eye is also adept at noticing adjacent parts on a product that have different levels of orange peel. Component parts made at different times or from different materials must have similar levels of texture or they can visually clash, reducing the overall perception of finish quality.

An example of this effect is seen in the automotive industry where the finish on plastic bumpers and filler caps must harmonise with surrounding steel bodywork to maintain the required visual impact.

The appearance and severity of orange peel on a surface is determined by factors including the substrate material, application method, formulation of coating, orientation of the surface during coating (horizontal or vertical), application conditions (temperature and humidity), application film weight, curing times and the skill and experience of the applicator.

Orange peel effects are ubiquitous in powder coatings, where a statically applied dry coating is fused together during the curing process to form a smooth hard finish. Orange peel forms more readily on thinly applied powder coatings so the

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Right: Ten orange peel assessment panels are shown with a test pattern reflected in the surface

A high gloss painted surface with haze looks milky and has a shallow depth of finish

Reflected light sources seen in surfaces with medium and high haze values

The Rhopoint RIQ parameter shows a linear relationship with visual assessment of orange peel on the 10 test panels

Table 1. DOI measurements are not sensitive to increases in orange peel from panel 5 and above

	1	2	3	4	5	6	7	8	9	10
IQ DOI	39.0	49.1	73.2	86.0	90.8	96.2	97.1	98.0	98.3	98.7
W/S DOI	70.3	73.5	80.6	91.7	89.6	95.4	94.8	93.8	94.8	95.0
RIQ	17.1	24.6	47.2	56.2	66.7	76.0	81.3	89.4	92.5	95.3

tendency can be to over apply the coating to avoid this effect.

For most high gloss coatings some degree of orange peel is inevitable, the challenge is to monitor and carefully control this effect. To achieve this level of control by eye is almost impossible, so instrumental methods are preferred.

DISTINCTNESS OF IMAGE

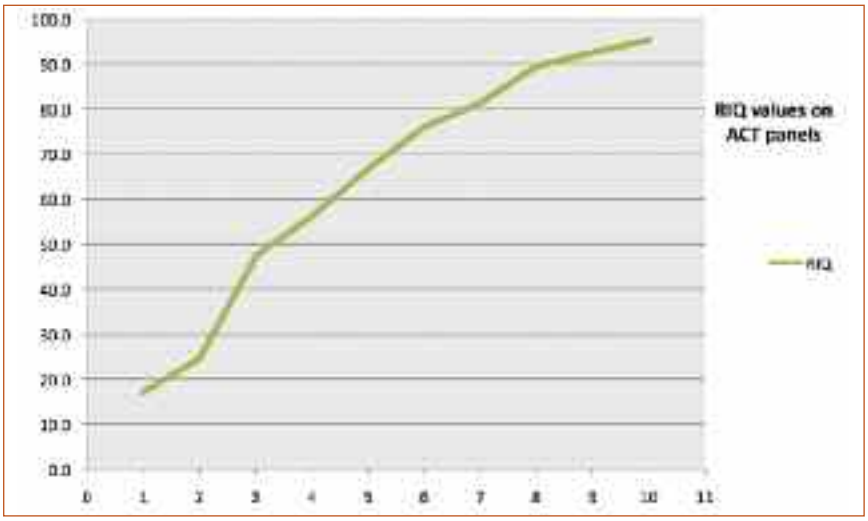
Distinctness of Image (DOI) was one of the first methods developed to evaluate surface texture; it was originally a visual and instrumental measurement.

DOI is a function of the sharpness of a reflected image in a coating surface. As more orange peel becomes visible on a surface, the distinctness of the reflected image becomes lower.

This effect is measured instrumentally by quantifying the way that light is reflected around the specular angle, a perfectly smooth surface with sharp reflection has a DOI of 100, decreasing with the amount of orange peel present.

While the DOI parameter was suitable for the fineness of finish available around the time of its development, the quality of today's coatings has increased to a point where DOI is a much less relevant measurement in many industries.

An example is the automotive industry where DOI is rarely used because coatings with marked orange peel can easily achieve a high DOI of 90 or higher.



RIQ MEASUREMENT

Rhopoint has developed a new measurement parameter for orange peel called Reflected Image Quality (RIQ).

RIQ describes the quality of a reflected image with much higher resolution than DOI, with a more proportionate response to perceived surface quality.

To demonstrate this proportionate response 10 visually graded automotive orange peel panels were measured using existing DOI measurements and the new RIQ scale.

The DOI of the 10 panels was measured instrumentally using Rhopoint DOI and a widely used automotive DOI instrument. The results indicate marginal differences in DOI from panels 4 or 5 and above. The low measurement resolution of the DOI parameter makes it very difficult to measure orange peel differences on the highest quality surfaces.

The panels were re-measured using the RIQ parameter. This metric has superior resolution for the higher quality surfaces and a response that is broadly proportionate with the visually graded panels.

HAZE

Reflection haze is an optical effect caused by microscopic textures or residue on a coated surface. It can be seen as a milky finish apparent on the surface with loss of reflected contrast also known as depth of finish. Halos and patterns can be viewed around reflections of strong reflected light sources.

It is often caused by poor dispersion, raw material incompatibility, additive migration, vehicle quality or incorrect stoving, drying or curing conditions.

Other sources of haze are polishing marks, fine scratches, ageing, oxidisation, poor cleanliness and surface residue.

CONCLUSION

High quality products require a smooth homogeneous finish that cannot be adequately controlled with a simple glossmeter.

Effects such as orange peel and haze, which reduce appearance quality are not generally measured because of the availability or cost of instrumentation.

The Rhopoint IQ provides the measurement parameters required for a more complete control of surface quality in a simple to use but affordable package.