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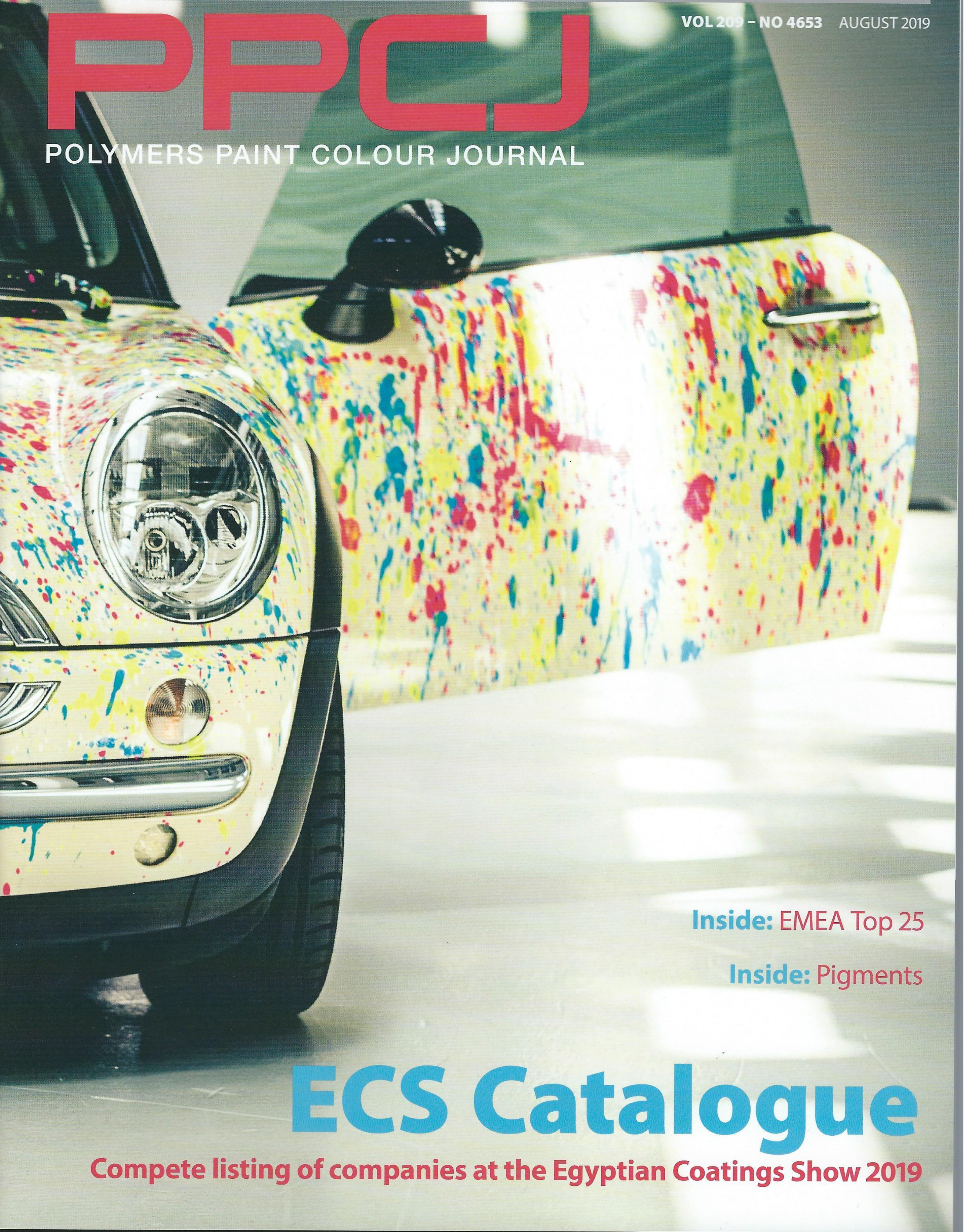

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Werner Rudolf Cramer discusses the different geometries of current measuring instruments and sheds light on their necessity

Modern measurement of effect pigments – useful and useless geometries

The selection of necessary measurement geometries is based on the optical-physical properties of the pigments. As a rule, one geometry is sufficient to read colour pigments in a car colour. Usually, this is illuminated at 45° and measured at 0° (from the normal). Alternatively, sphere geometry is used. To measure aluminium pigments with their varying brightnesses, several geometries are needed to detect these brightness changes. Measurements at a fixed illumination and aspecular angles show the increase in brightness the closer to gloss is measured. Due to the Fresnel law, these changes in brightness are not linear.

Particular attention is paid to the interference pigments found in most car colours. The colourful interference pigments change their brightness and their colour, while white interference pigments show no colour changes.

The optical properties of the interference pigments are described by the interference law. This law shows the dependence of the resulting colour on the angle of the incident light. The flatter the illumination, the more the reflection maximum shifts to shorter wavelengths, ie red interference pigment turns yellow, a green one gets bluer and it increases non-linearly. If these properties are not met, the colour measurement is not plausible **(Figure 1)**.

Due to these optical-physical properties, interference pigments can be optimally described with three illumination angles: a steep (eg 15°), the classic at 45° and a flat angle (eg 65°) with the same difference angle of 15°. Illumination angles that lie between these geometries result in no additional information **(Figure 2)**.

The closer to the gloss angle, the larger the differences in the reflection peaks (maxima) become. Mostly, this series "breaks off" at 5° from gloss. Often the measurements at 10° off gloss appear critical. The usual 15° of gloss (aspecular) is "stable" at all illumination angles **(Figure 3)**.

If a colourful, transparent interference pigment is applied to a white background as described above, the measurements at a fixed illumination of 45° produce a colour change between the reflection and the transmission colour in the range of 20° and 30° from the gloss angle **(Figure 4)**.

VISUAL ASSESSMENT

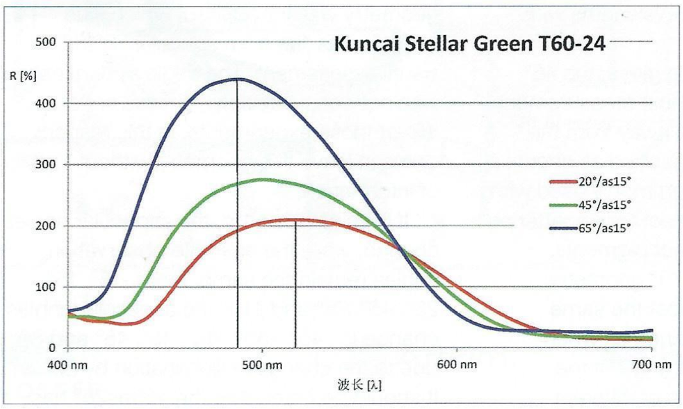
When considering appropriate angles to describe the pigments, visual assessment plays a major role. It is the most important appraisal for the colour nuanceur. In doing so, he checks the panel at a window or in a light booth. It starts with the panel or the panels in a position in or near gloss. From this position he tilts the panel downwards and upwards. In this process, the absolute positions of the light source and that of the observer always remain the same as the angle between the two.

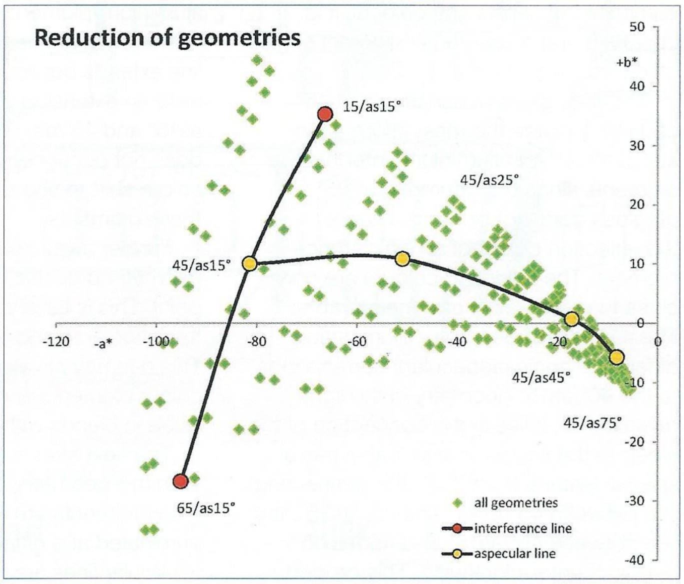
If the observer tilts the panels downwards, the illumination moves in the direction of the normal, then changes to the other side of the normal and the aspecular angle becomes larger. If the panels are tilted up to the observer, the illumination and observation as well as the difference angle to the gloss become larger. If you compare the two processes, the result is almost the same colour shift.

The nuanceur takes care of these reactions in the visual assessment, which he uses to assess and as a starting point for his further course of action. This raises the question, what do the measured values of common, portable measuring instruments provide? What are the correlations between visual matching, optical properties and measurement results?

Figure 1. Below: With flatter illumination of interference pigments, their maxima shift to shorter wavelength. At the same time their maxima increase

Figure 2. a*b*-values of many geometries show a pattern which can be reduced on a few geometries. These geometries characterise any interference pigment





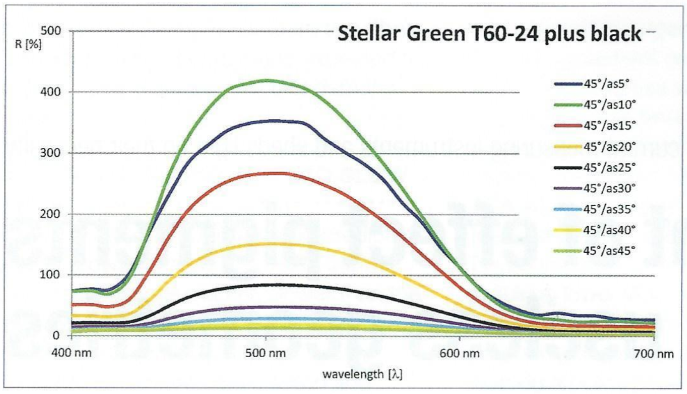


Figure 3. Readings at 5° off gloss are not plausible because the difference between maxima must increase

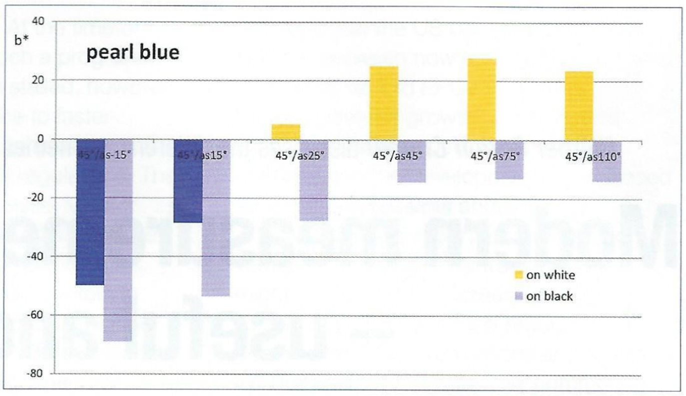


Figure 4. Colour interference pigments change their reflection colour to the complementary transmission colour if applied on a white ground. The transition area is between 20° and 30° off gloss. With portable instruments you find the change mostly between 45°/as25° and 45°/as45°

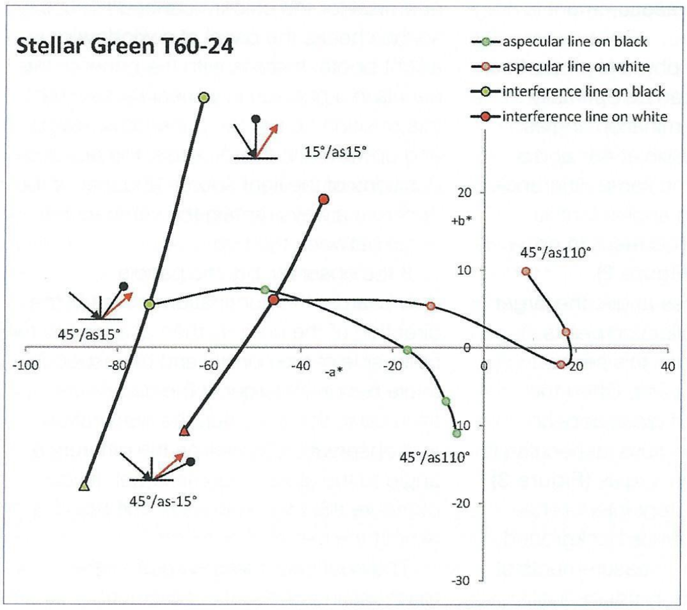


Figure 5. Typical description of an interference pigment: Interference lines are based on values measured near gloss. And aspecular lines are going off gloss. At 45°/as75° and 45°/as110° there are strange behaviours on a white ground

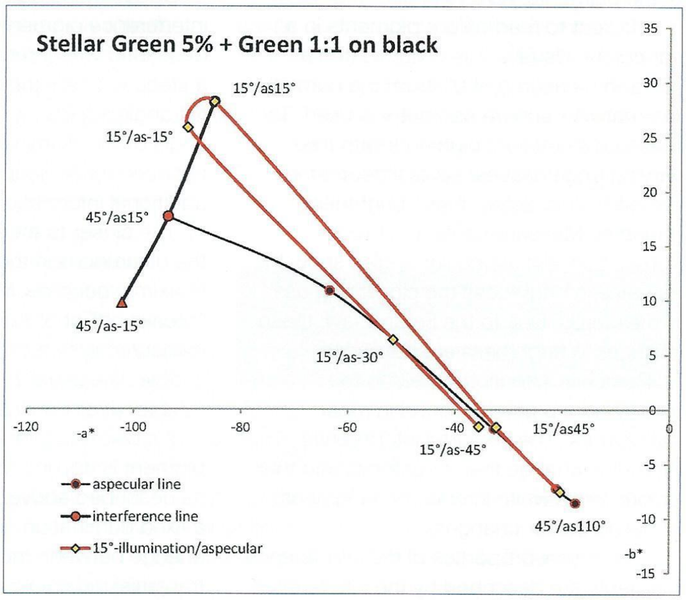


Figure 6. Except 15°/as15°, aspecular geometries at 15°-illumination show no additional information to describe an interference pigment

CORRELATIONS

The standard angle of illumination is 45°. At this angle, the measuring instruments illuminate the panels and objects. It is observed and measured at different angles off gloss.

The near gloss observations at 15° and -15° provide the most information about the effect (aluminium, interference pigment), since the geometry at 25° off gloss does not or hardly covers the reflection colour of an interference pigment: The reflection colours are only close to gloss visible and measurable. The 45°/as -15° geometry (illumination/difference angle (aspecular)) corresponds to the 60°/as15° geometry in the light reversal. So, it lies in the connection of the steep to the flat geometry. It also has a special feature: If you take the connecting line between 45°/as15° and 45°/as25°, the line between 45°/as15° and 45°/as-15° bends counter-clockwise. This property occurs in all colour interference pigments **(Figure 5)**.

If this behaviour is compared with that of an aluminium pigment or of an aluminium-pigmented coating or of a white interference pigment, the aforementioned line extends between 45°/as-15° and 45°/as15° in extension of the line between 45°/as15° and 45°/as25°. A bending of the line does not occur here, since there is no colour shift to shorter wavelengths with these pigments.

Further away from the gloss, the 45° geometry provides the next measurement point. This is far enough away from the transition area and is classified as uncritical. This geometry is also commonly used with colour pigments and reflects the scattering levels in blends with effect pigments.

The next step is the 75° geometry. With this geometry, almost the same measurements are obtained as when illuminated at a different angle: If the aspecular lines are taken at different illumination angles, they run in the same direction. Distinctions are only conditionally possible. For this reason, a waiver of this geometry is possible.

Even further away from the gloss is the 110° geometry. The observer judges the sample at an angle below the illumination angle. The signal is very low and results are generated especially on white ground, which can be classified as artefacts. This geometry was introduced, which was classified as "far from specular" in the visual assessment. The angle of illumination was not considered, which was not at 45° at those experiments. In this respect one can leave this geometry without loss of information.

If illuminated at 15°, the aspecular angles change, while the absolute observation angles remain the same. From -15°, 15°, 25°, 45°, 75° and 110° the aspecular angles change to -45°, -30°, -15°, 15°, 45° and 80° due to the change of illumination by 30°. It should be noted that the 45°/as25° has no counterpart – it would be 15°/as-5° – as well as the geometry 15°/as30° has no counterpart – it would be 45°/as0°.

With 45° illumination, the aspecular angles move away from the gloss angle in fixed steps. With the 15° illumination, they change sides (cis and trans) several times in relation to the gloss angle. Basically, it can be stated that measured values approach gloss-distant geometries. Two examples: The measured values of two geometries 15°/as80° and 45°/as110° barely differ, just as the measured values of the geometries 15°/as45° and 15°/as-45°. In this respect, one has no information gain with these measuring geometries **(Figure 6)**.

With aspecular geometries at 15° illumination, only the 15°/as15° geometry can be used. It stands for a steep illumination. The 15°/as-15° geometry provides measured values which are between 15°/as15° and 45°/as15° and therefore, superfluous: In the light reversal, 15°/as-15° becomes the 30°/as15 geometry.

All geometries up to the 15°/as15° do not provide additional information for the characterisation and identification of interference pigments.

Comparing the geometries of the visual interpolations with those of the portable devices, there is a large discrepancy. In both methods, the assessment begins near gloss, in the visual assessment with a steep and in the instrumental assessment with the classical illumination angle. With colour interference pigments, colour differences can be seen here.
In both methods, the aspecular angle, ie the difference angle of the gloss is bigger. While the illumination angle remains constant during the instrumental procedure, it changes during visual matching. With this knowledge, the results of the instrumental measurement can be well assigned, even if they do not correlate directly with the visual ones.

The interference shift can also be visually adjusted by moving the pattern sheet down parallel from eye level, while illuminating from flat to steep. The aspecular shift due to the change of the aspecular angle can be adjusted visually only if the illumination is fixed on the panel and tilted with it.

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This paper was presented at the 2019 ECC, in Nuremberg, Germany

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BASF to launch new pigments at K

BASF will present innovation highlights from its broad range of Colors & Effects® pigments for plastic applications at the K trade fair in Dusseldorf, Germany, from October 16-23, in hall 5 at stand C41.

The new product launches include two new Lumina Royal effect pigments, Microlen Piano Black and a black and red addition to the Sicopal product line, which are especially recommended for recycling materials and demanding applications. Featuring these latest innovations, as well as other key pigment chemistries, BASF's Colors and Effects brand will reveal a customised Color Collection created by Pantone®. Comprised of three palettes with seven colours each, the collection will highlight current consumer trends and address how pigments can meet the plastic industry's versatile colourant requirements with safe, reliable and brilliant performance.

"With our pipeline of current and future pigment innovations, we have set a special focus on meeting emerging industry requirements," said Christof Kujat, New Business Development Manager, Pigments for Plastics.

"Our research and development covers the broad plastics industry, from packaging and consumer goods to automotive and fibres. We require unmatched pigment performance in order to achieve high safety standards, as well as chemistries that enable durable chemical performance and colouristic brilliance," he added.

Speciality chemicals company launches its first pigment range

Devine Chemicals, a Consett, UK-based speciality chemicals distributor and manufacturer, has launched DeLOUR, its first range of pigments. This will further strengthen the company's diverse portfolio and help to cement its position as a leader in the speciality chemicals market.

The DeLOUR pigments are a range of phthalocyanines available in blue and green and are appropriate for both water-based and solvent-based applications. Tailormade for the coatings, inks and plastics markets, the pigments have been optimised to give UV stability, solvent fastness, light fastness and chemical resistance.

Devine Chemicals also offers a range of products for the coatings, inks and plastics markets including its own range of DeCAL grades which comprise a wide range of thickeners, dispersing agents and defoamers for aqueous and non-aqueous systems, as well as acrylic polymers for inks and coatings and associated auxiliary chemicals. The company offers its own range of titanium dioxide, DeTOX that is available in chloride, sulphate and anatase grades.

Dan Devine, pictured, Commercial Director at Devine Chemicals, said: "The launch of the DeLOUR pigment range is an important milestone for Devine Chemicals as we remain focused on strengthening our product portfolio through extensive research and development, anticipating changes in the market and delivering the right solutions for our customers.

"We had identified a gap in the market and an opportunity to strengthen our portfolio and after vigorous testing we are thrilled to be able to offer our customers the new DeLOUR range. This product range is another example of how our business is committed to serving the coatings, inks and plastics markets."

Devine Chemicals has more than 30 years' experience in supplying speciality chemicals internationally and for use in many sectors, including building and construction, coatings, adhesives, textiles, agrochemicals, paint, plastics, rubber and homecare.

The company offers a trusted and personal service with full technical support and a comprehensive after-sales service, supported by the team's in-depth knowledge of speciality chemicals and their applications.