

Increasingly stringent regulatory, environmental and performance demands mean pigment producers are looking beyond aesthetics in their developments. Peter Mapleston finds out more

Pigments move beyond aesthetics

The latest developments in pigments for plastics are a response to market demands that go well beyond aesthetics. Increasingly, they are providing answers to environmental questions. The trend to substitution of heavy metals, through the use of new inorganic and organic pigments, has been ongoing for some years. Now, that has been supplemented with a growing interest in pigments derived from renewables. And, more recently, a strong focus on pigments that can replace carbon black.

Carbon black is a highly effective pigment but it has a big disadvantage in applications such as single-use packaging, where it makes the plastics material virtually invisible in the automated Near Infrared (NIR) sorting equipment used in post-consumer recycling operations. So a host of new alternatives is now being made available from various suppliers. These are not as black as carbon, but in many cases that may work in their favour, with brands opting for very dark blues or blacks for a slightly different look.

However, innovation is not focused solely on environmental concerns. With the continuing

growth in the use of engineering plastics in applications that, for various reasons, benefit from colour, new pigments are emerging that offer the heat resistance to survive high temperatures in both processing and in use. This article takes a look at some of the latest moves by pigment suppliers to the plastics industry.

Milliken is one of the world's largest colorant producers, with products for polyurethanes as well as thermoplastics and particularly – through its long-established ClearTint polymeric colorants – for PP-based consumer packaging. Its 2017 acquisition of Keystone Aniline Corporation – an important supplier of dyes, pigments, pigment dispersions and polymers – extended its offering into amorphous thermoplastics such as PS, PET, acrylics, and engineering thermoplastics (ETPs).

Recently introduced products for ETPs include pigments suitable for resins with processing temperatures from around 250 to 300°C, and in some cases higher, says Sami Palanisami, Market Manager KeyPlast Colorants for Plastics. For some time, he says, there has been a lack of vibrant

Main image: Colour has to be matched by long term stability, favourable environmental profile, and compliance with increasingly stringent regulations in development of today's performance pigments

Right: This yellow is one of a line of 12 new colours for engineering thermoplastics in the KeyPlast Resist range from Milliken

colours that could withstand these sorts of temperatures, due largely to the withdrawal of cadmium-based pigments. "We saw some gaps in the market, especially in oranges," he says.

The company introduced a range of 12 products to fill this perceived gap at K2019 late last year under the KeyPlast Resist banner. They are suitable for use with resins such as polyamides, polysulphones, modified PPO (SABIC's Noryl, for example), and a number of other high-heat polymers and alloys. The range includes five reds, one orange, three yellows, a green, a blue, and a violet black.

The PA challenge

PA resins in particular have provided significant colouring challenges in the past due to their chemical composition, Palanisami says. "At first, many thought this problem to be related to the high heat processing requirements for nylons. But subsequent research revealed that normal colorants are reacted with the amide group and ruined by discoloration due to the loss of conjugation in the colorant molecule."

Palanisami explains that precisely-controlled colouration is often required in PA applications, such as components for power tools, automotive components, gears, and appliances. He says KeyPlast Resist grades can be used effectively with unfilled, glass reinforced, and flame retardant compounds. "They are high purity and perform well in the high-temperature and chemically-reductive conditions typically associated with high-performance polymers," he says.

The KeyPlast Resist grades are said to be highly soluble in the polymer matrix and disperse well without leaving specks or streaking. As they are



IMAGE: MILLIKEN

non-nucleating, they will not induce warpage or create dimensional stability issues, the company says. They are also non-abrasive, so they will not affect glass fibre properties.

Milliken says the new products were well received at the K show, and this has resulted in some fast approvals at polymer suppliers.

Milliken says it is continuing to work on developments in the KeyPlast Resist range, with the aim of further improving thermal and light stability. Palanisami says

he sees good prospects for products in applications such as electric vehicles, for example, where yellows, reds, and oranges are required for ID purposes. Pigments for such purposes must withstand high temperatures in both processing and use. He says the company is also carrying out more approval testing to ensure colours perform to specification in compounds containing a variety of different additives.

The company says it is also investing heavily in new proprietary chemistries beyond those it currently uses. It says it plans to introduce products based on new molecules in the red and orange range early next year. Target applications will include high-speed charging systems for EVs.

Regulatory drivers

Regulation and performance are critical factors in pigment selection in today's marketplace, according to Scott Heitzman, Business Development Manager - Plastics, **Sun Chemical Performance Pigments**. "In many cases, replacing diarylides or heavy metal yellows for better compliance in injection molded parts is now a regulatory requirement or technical need," he says.

Heitzman cites the example of the company's new Fanchon Yellow 191 279-9191 pigment as both an economical and high-performance red shade yellow. It is globally-compliant and FDA approved in conditions B-H up to a 1% loading. It also delivers heat fastness in most polymer systems to 275°C to 300°C. He also highlights its new phthalocyanines (PCNs). Fastogen Blue 248-55AE is a hemi-chlorinated PB 15:1 specifically designed for injection moulding that will deliver "durable red shade blue colour at high temperatures and performs very well at low concentrations across a variety of polymers," he says. Also new is SunFast Green 264-77FF, which was originally intended for colouring fibre but is now finding use in injection

Below: Many pigment suppliers see opportunity in EV technology, which places high demands on colorants



IMAGE: SHUTTERSTOCK

moulding applications where it can help solve dispersion problems and improve colouring of thin wall-section parts.

Lanxess, which is the world's largest manufacturer of iron-oxide pigments and a leading producer of chrome oxide pigments, is also active in developing colours with improved thermal resistance. Its Colortherm brand features a range of synthetic red iron-oxide pigments that are said to provide better thermal stability than comparable pigments. The company attributes this to its proprietary Laux production process, which involves heating the pigments to temperatures as high as 800°C to force traces of water that could cause a colour shift out of the crystal lattice. As a result, the pigments can be processed at temperatures well in excess of 300°C without problem.

Development of a portfolio of pigments for high temperature applications has also been a priority at **BASF Colors & Effects** (at the time of writing part of BASF but it is in the process of being acquired by Sun Chemical parent, DIC). Its latest product launches include Sicopal pigments in the red, turquoise and green colour space, as well as Cinquasia Rubine K 4370 FK, which is optimised for use in Unfilled and glass reinforced PA compounds.

Below: Clariant is one of several pigment suppliers offering black products suitable for automated NIR recycling sorting systems

Sustainability matters

Aside from the thermal challenges, many new developments in colorants are addressing environmental concerns and the growth of the Circular Economy. "The organic pigment market will face various challenges driven by the acceleration of the plastics sustainability agenda," says Philippe Lazerme, Head of Marketing in the Business Unit Pigments at **Clariant**. "Everything indicates that the

packaging market will be the most impacted. The largest brand owners and packaging producers have committed themselves to use less plastic packaging. Those who continue using plastic packaging will potentially increase the amounts of recycled polymers to up to 70% within the next decade."

The challenges faced with recycled polymers are manifold and most definitely extend to colour, says Andreas Buder, Global Technical Marketing Manager Plastics in the Clariant pigments business. "First of all, the ground tone is greyish and extremely inconsistent. It will be a particular challenge for packaging designers and masterbatch producers to create and match a specific colour which should still be visually appealing."

Lazerme and Buder say that to support both designer and colour matcher, Clariant Pigments has worked with Konica Minolta and Matchmycolor (owner of the Colibri colour communication, matching, and quality control software tools) to prove the suitability of its "Clariant pigment calibration set" to match recycled polyolefins. The pair say that using this calibration set and the Konica software "it becomes increasingly easy to match a strong and appealing colour in just a few steps." The company currently offers the calibration set to its customers and to downstream companies that may need it.

The other important challenge, they say, is the safety, not only of the recycled polymers, but also of the workers compounding and processing the recycled polymers. "To avoid the release of harmful substances after a certain number of recycling loops the use of particular stable pigments is essential. The chemical structure of a pigment doesn't allow any conclusions about its suitability for recycling," Buder says.

Potential pigment-related NIAS (Non-Intentionally Added Substances) can originate from reactants used for synthesis or the pigment itself as they differ in their stability, he says. "Depending on process conditions, exposure during product life, and reprocessing conditions during recycling, some materials might be less stable and migrate or evaporate more easily. Therefore, it is essential to rely on pigments that have been accurately tested under recycling conditions."

Alternative blacks

For post-consumer recycling to succeed, effective high speed sorting of plastics into different polymer types is critical. To this end, Clariant Pigments has developed a black colorant – Graphot Black CLN – and two black polymer soluble dyes – Solvaperm Black PCR and Polysynthren Black H – for sorting of black polymers by NIR



IMAGE: CLARIANT

IMAGE: ISTOCK/FERRO



Above: Ferro has added two NIR-detectable black pigments to its product slate

sorting devices. They provide an alternative to carbon black, which normally cannot be recognised by NIR sorting scanners because it absorbs the radiation (it should be noted that carbon black producer **Cabot** says it is working with a number of partners to develop sorting technologies for post-consumer plastics capable of identifying materials containing carbon black).

For packaging applications, Clariant says the Graphtol Black CLN pigment is intended for polyolefins while Solvaperm Black PCR is developed for PET, PS, and PC. Both are food contact approved in selected countries worldwide. Polysynthren Black H is intended for packaging and E&E applications using PC, PMMA, ABS, PBT, compact and expanded PS, as well as PET. "Of particular significance, Polysynthren Black H is one of very few colorants suitable for polyamides, the largest family of engineering plastics," Clariant says.

At **Shepherd Color**, Marketing Manager Mark Ryan says that to address sustainability and recycling issues, the company "has gone beyond the visual into the hyperspectral by using wavelengths of light outside of our visual perception." He says the company has applied its 40-years of experience in IR Black pigments to provide a highly effective solution to the challenge of sorting black plastics. Shepherd Color Black 10P925 is optimised for colouring black food trays, especially in polyolefin resins, and has a dark, neutral mass tone colour.

The Black 10P925 product is designed for virgin plastics; the company has developed Black 10P950 for post-consumer recycle. "PCR can come in a range of colours and Black 10P950 provides high colouring strength to help overcome the inherent colour while still maintaining the NIR visibility properties needed to allow the material to be sorted again," says Ryan. Both are said to be highly inert, inorganic pigments that are heat stable and non-migratory in a wide range of plastics. The company also says they will not degrade or change colour over multiple extrusions, and hold a wide

range of regulatory approvals around the world.

Ferro has also introduced new NIR-detectable black pigments for packaging applications. Its inorganic pigments 24-3950 FCP (PBr29) and Nubifer NB-803K FCP (PBk33) are formulated to reflect light from the emitter, allowing recycling system sensors to correctly identify and sort the plastic. Developed over two years, the NIR reflecting blacks are part of the company's food contact plastics product range, which includes European AP89(1) certification for each lot and compliance with the requirements of EU 10/2011 regarding plastic packaging in contact with food. They also carry FDA approval (FDA 21 CFR 178.3297) for use at up to 5% based on final formulation.

BASF Colors & Effects recently-launched Sicopal Black K 0098 FK. It was developed to optimise the recycling of black plastics, particularly packaging, and has now received food contact approval in both Europe and the US. The company says compliance will be extended in the near future to include other regions.

Within the **AF-Color** branch of independent compounder Akro-Plastic, the portfolio of masterbatches has also been extended to include carbon black-free color formulations. These are marketed under the AF-Color IR name.

Cool solutions

Taking another angle on black and NIR, **Lanxess** has developed a black pigment that it says reflects 20% more of the sun's near-infrared radiation (NIR) than conventional products. Plastic roofs and façade elements that are coloured with Bayferrox 303 T heat up less when exposed to solar radiation, meaning that the building's internal environment can be kept cooler. "The temperature in a polymer matrix coloured with Bayferrox 303 T is as much as 8°C lower than when a conventional black pigment is used," says Stefano Bartolucci, Global Market Segment Manager for Plastics in the company's



IMAGE: BASF COLORS & EFFECTS

Right: Food trays pigmented with Sicopal Black pigment allow NIR sorting in recycling operations

Right: Lanxess has developed a black pigment that reflects 20% more of the sun's near-infrared radiation (NIR) than conventional products, controlling thermal heating

Inorganic Pigments Group (IPG).

Use of the pigment can also extend the service life of a plastic component considerably, as the thermal decomposition of the polymer matrix is reduced due to lower heat absorption. In addition, the difference between daytime and night-time temperatures is less extreme so plastic components are exposed to reduced thermomechanical stresses, which can lead to crack formation or even bursting. "Bayferrox 303 T's characteristics also make it suitable for use in the automotive industry, to colour the dashboard for example, which is exposed to high and sustained solar radiation," says Bartolucci.

Colouring bioplastics

Colouring of bioplastics is gaining increasing importance, and is usually achieved with colour masterbatches consisting of a polymer carrier material and the respective pigments. The AF-Eco colour masterbatches from the **Bio-Fed** branch of Akro-Plastic are made with biodegradable carrier polymers. The portfolio now includes a broad range of biodegradable masterbatch carriers and products include carbon black-free dark types. "These new products have been developed to meet the requirements of every biodegradable plastics application and their increasing complexity, also minimising the interactions with other polymer components of the compound," says the

IMAGE: LANXESS



company. It says the AF-Eco products contain pigments certified in accordance with the OK Compost Industrial and EN 13432 standards on biodegradability of plastics (EN 13432 limits the non-biodegradable material content to a maximum of 5% and 1% per individual pigment).

The **BASF Colors & Effects** brand now also includes a growing portfolio intended for use with compostable materials that meet EN 13432 requirements. Further innovations from the company include what it describes as a colour collection optimised for contemporary plastic design. It says the collection "shows how new colorants enable current consumer trends and highlight how sustainable pigments meet the industries diverse demands for safety, reliability and brilliance in plastics coloration."

The most relevant pigment consumption trends include high chemical purity, waste management and demanding engineering plastics, according to Marc Dumont, Head of Global Industry Management Plastics at BASF Colors & Effects, who adds

Colour forecasting in a time of Covid

Every year, many of the leading companies involved in colour put out their views on trends for the coming months. Most of those have been researched over many months and pre-dated the global impact of the Covid-19 pandemic.

The first post-Covid forecast comes from Ampacet. Discussing colour trends back in April the company's Insight and Innovation Director

The Covid-19 pandemic will have an impact on future colour trends

Linda Carroll said: "Prevailing, regional socio - economic conditions have always been a primary influencer of colour direction. This current pandemic, however, will influence colour preference on a global scale in four areas.

"The desire for health and wellness will be reflected in the desire for clean, aquatic blues and lifted, organic green palattes. Our personal sanctuaries have been threatened during this period of unrest, which will result in consumers gravitating to the global colour of trust and integrity, blue."

Carroll explained this would certainly have an impact on colour trends. "The pandemic infused a pervasive feeling of gloom and futility. Fortunately, human resiliency will prevail, and many will gravitate to colours of optimism and hope found in vibrant oranges (colour of fierce independence) and bright, sunshine yellow values," she said.

"Finally, our desire for balance will be tempered by a sense of trepidation due to the unknown economic impact of the pandemic. As a result, earthy browns, and their clear association with physical and intellectual grounding, and the enriched purples - the colour of mystery and spirituality, will find devotees."

> www.ampacet.com

Right: Bio-Fed offers a full portfolio of masterbatches made with biodegradable carrier polymers

that the global plastics industry also faces increasingly stringent regulations in sensitive applications such as food contact materials and toys. Accordingly, Colors & Effects has been extending its Utmost Purity pigment range, which it launched last year with the introduction of Irgazin Red K 3840 UP. This has now been joined by Heliogen Blue K 7097 UP. Dumont says the pigments are intended to allow users to keep ahead of regulatory changes and are supported by food contact certificates.

For consumer goods, where bright colours and sparkling effects are often an important selling factor, Colors & Effects has launched Irgazin Rubine K 4082, which Dumont says is an improved Rubine DPP pigment. "Its extreme transparency turns it into an excellent formulation partner for brilliant effect pigments like Lumina Royal Russet to achieve vivid lava reds with strong sparkling effects," he says. High chemical purity also enables the new pigments to meet global regulations for food contact.

Expanding capacity

Canada's **DCL Corporation** – the result of the 2018 merger of Dominion Colour Corp and Lansco Colors – has been building new high performance pigment capacity that was commissioned a few weeks ago. "We believe this may be the first investment in new capacity of its kind in North America for decades," says Frank P Lavieri, Executive Vice President Sales & Marketing at the company. "We intend to manufacture Hansa and benzimidazolone yellows primarily for the coatings industry, and calcium salt azo yellows (Yellow 62, 168, 183, 191) and Yellow 155 primarily for the plastics industry. We feel that this new capacity will meet a need for high quality pigments available with short lead times."

Meanwhile, **Lanxess** has added to its technical services for pigment customers. Its IPG business



unit now has an expanded technical centre in operation at its largest site in Krefeld-Uerdingen, Germany. The facility is equipped to carry out automated measurement of thermal stability in customer-specific plastics applications. "From sample-loading to colorimetric analysis, all the necessary modules can be actuated via automated processes," says Bartolucci. "That allows us to carry out highly specific tests with supreme accuracy."

Lanxess now also offers extensive pigment expertise for colouring filaments for 3D print applications. At the Uerdingen centre it can carry out in-depth tests on the effects of pigments, and advise customers on colouring with iron-oxide pigments. "For example, in the case of short dwell times and relatively low shear forces in the processing machines, it is necessary to ensure good dispersibility," says Bartolucci.

"The pigments need to be easy to distribute and must reach their final colour strength quickly," he says. "At the same time, we can demonstrate ways of partially reducing the organic pigment content in a filament formulation by means of iron oxides, when the application calls for better weather stability." Bartolucci also says that, in contrast to organic colorants, inorganic pigments provide high temperature and weather stability at relatively low costs, as well as excellent migration resistance.

CLICK ON THE LINKS FOR MORE INFORMATION:

- > www.milliken.com
- > www.sunchemical.com
- > www.lanxess.com
- > www.colors-effects.eu
- > www.clariant.com
- > www.cabotcorp.com
- > www.shepherdcolor.com
- > www.ferro.com
- > www.af-color.com
- > www.bio-fed.com
- > www.pigments.com (DCL Corporation)

Below: Lanxess has expanded its technical centre at its largest pigments site at Krefeld-Uerdingen, Germany



IMAGE: LANXESS