Colors for the High-Performance Sector

How Plastics Processors Find the Most Suitable Colorants for High-Performance Polymers

Colored plastics are not just a marketing gimmick, but fulfill important functions with technical components. In particular, they warn of hazards and permit the fast and direct identification of components. However, when coloring such plastic components, the processors are faced with several difficulties. For example, the colorants used must exhibit long-term resistance to high temperatures and must not impair the polymer's mechanical properties. Therefore, when selecting the colorant, compounders and processors must observe several important points.

© Rowa Masterbatch

Because they exhibit better mechanical properties as well as higher resistance to chemicals and heat, high-performance plastics meet higher demands than standard and technical plastics. Due to these characteristics, the application range for high-performance thermoplastics has increased considerably in the past years. Typical examples are found all around battery electrics. Because of the increasing importance of electromobility – where products with long service life and high dimensional stability under heat are required – they play a far more important role. Similarly, digitalization requires very demanding solutions for high-efficiency electronic components.

Common to many of the application areas is that on the one hand, the plastics used must meet the demands for resistance to high thermal loads, and on the other they must ensure a wide color range, in particular for bright colors. Because in many cases, good distinguishability is essential, e.g. for high-voltage cables and connecting elements in hybrid and electric vehicles, which must be marked with orange colors. Moreover, the color must exhibit safety-relevant features clearly, also after long periods of use or high continuous operating temperatures. For example, important markings like on emergency Off switches must not bleach out. That is why colorants with particularly high temperature resistance are necessary to ensure that the component retains its color and function also under thermal loading. By selecting suitable colorants, also brilliant colors such as RAL 1021 rape yellow, RAL 2010 signal orange, RAL 3000 flame red, RAL 4006 traffic purple, RAL 5015 sky blue, and RAL 6018 yellow green are possible.

Finding the Most Suitable Masterbatch Jointly

Consequently, the coloring of high-performance plastics is a particular challenge. Apart from high expertise, close and trusting cooperation between masterbatch producers and customers is also required. These customers include processors, such as injection molders or extruders, as well as compounders. The differences in cooperation consist mainly in that compounders have original recipe expertise and therefore detailed know-how that is not readily available for processors. Moreover, the processor is primarily concerned with the respective component requirements.

For both sides, however, an open dialog with the masterbatch producer is an essential prerequisite for optimum results. Only if detailed information is available about the polymer or compound to be colored, and the requirements for the component, are masterbatch producers such as Rowa Masterbatch able to develop a customized color masterbatch. There- »

For color matching, large DIN A5 test panels (210 x 148 x 4 mm, shot weight about 135 g) are produced on a 200-ton injection molder
© Rowa Group

fore, a confidentiality agreement is a basic requirement for cooperation in most cases.

Various criteria for colorant selection must be carefully examined:

Processing temperature of the polymer or compound: for masterbatch producers, this is an important criterion for correct colorant selection. The temperature resistance of the colorants used should be at least 10 °C above the processing temperature. Moreover, the colorant must be suitable for the polymer. Particularly with polymers that have only been on the market for a few years, adequate information from the colorant producers is not always available. Therefore, comprehensive suitability tests by the masterbatch producer are necessary.

Demands on the final product: detailed requirement profiles must always be prepared. Typical requirements are:

- high resistance to light and weather,
- high continuous operating temperatures,
- approval for contact with foodstuffs (e.g. EU 10/2011, FDA),
- product standards (e.g. test and delivery regulations of the automotive industry, UL and VDE specifications, standards in the building sector, etc.).

Pigment	Color index	Mohs hardness
Zinc sulfide	Pigment white 7	3.5
Cerium sulfide	Pigment orange 75 and 78, pigment red 265 and 275	4-5
Iron(III) oxide	Pigment red 101	5-6
Titanium dioxide (anatase)	Pigment white 6	5.5-6
Titanium dioxide (rutile)	Pigment white 6	6-6.5
Chrome titanium yellow	Pigment brown 24	6-6.5
Cobalt blue	Pigment blue 28	7.5-8.5
Chromium(III) oxide	Pigment green 17	9
Comparison materials		
Talcum		1
Glass fiber		5.5
Diamond		10

Table 1. Mohs hardness of different inorganic pigments Source: Rowa Masterbatch

Observing Reflectance Curves and Additives

Particularly in automobile manufacturing and in the decorative field, good agreement between the **reflectance curves** of color sample and reproduction is decisive. This prevents the occurrence of metamerism under different kinds of light (light source D65 = daylight, light source F2/F11 = fluorescent lamp light, or light source A = incandescent lamp light).

Many compounds contain **functional additives** such as filling and reinforcing substances, flame retardants, stabilizers, anti-friction agents, etc. During colorant selection, it is important to ensure that

The Author

Bernhard Scheffold is company manager of Rowa Masterbatch GmbH.

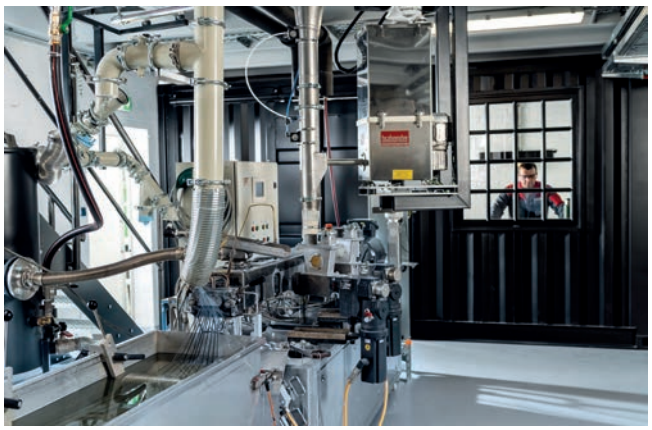
Service

References & Digital Version

↘ You can find the list of references and a PDF file of the article at *www.kunststoffe-international.com/archive*

German Version

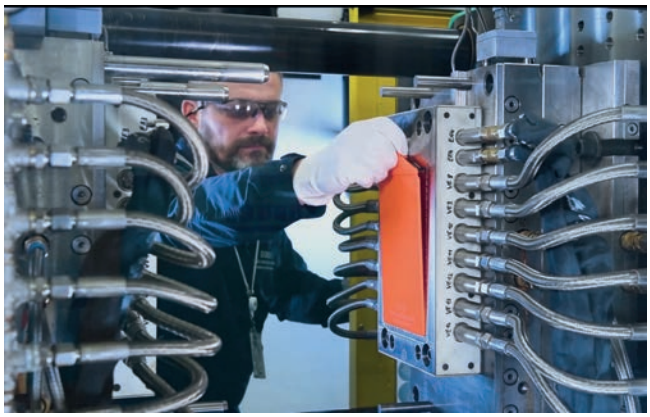
↘ Read the German version of the article in our magazine *Kunststoffe* or at *www.kunststoffe.de*



A co-rotating twin-screw extruder with coupled strand pelletizer is used for masterbatch production © Rowa Group

Individual inscription of colored panels is possible with the digital flat bed printing technology © Rowa Group

The customer's sample is inspected visually in the Color Competence Center, and the feasibility of the requirements investigated © Rowa Group



The colorist responsible for color development evaluates the color by means of injection molded sample platelets © Rowa Group

there are no interactions between the colorants used and these additives.

Also the **decomposition products** sometimes occurring in low concentrations in polymers during processing must be taken into account. For example, acid recipe constituents and/or acid decomposition products can cause the generation of hydrogen sulfide with zinc sulfide pigments (e.g. white pigment, P.W.7), ultramarine pigments (e.g. blue pigment, P.B.29) and cerium sulfide pigments (e.g. red-orange pigment, P.O.78).

What is more, colorants can have a significant effect of the **mechanical properties** of the final product. Organic pigments like copper phthalocyanine pigments (e.g. green or blue pigment), which exhibit high dispersion hardnesses, can lead to a significant reduction of breaking strength, breaking elongation, and impact resistance. Although high shear forces are introduced by efficient twin-screw extruders with high processing lengths during the production of corresponding masterbatches, the complete dispersion of all pigment agglomerates cannot be ensured in all cases. Usually, inorganic pigments are easier to disperse, but they exhibit higher hardness (**Table 1**). Usually, the Mohs hardness scale is used [1]. With glass fiber-reinforced compounds of the same Mohs hardness, the inorganic pigments used have a negative influence on the mechanical properties due to damaged fibers.

Organic or Inorganic Colorants?

The requirements mentioned above clearly limit the selection of colorants for technical plastics and high-temperature polymers. Therefore, the suitability of colorants available on the market must be tested and entered in a color recipe system. Moreover, in spite of the same color index, many colorants are not exchangeable 1:1. Consequently, for a producer of polymer-specific masterbatches, who claims to color all polymers available on the market, this means several hundred colorants.

Colorants Stable up to 380 °C

In addition, new colorants keep coming. Of particular interest for high-performance polymers are newly developed products, if they exhibit very good heat resistance as well as good light and weather resistance. Particularly in the past years, new inorganic pigments and more temperature-stable colorants for high-performance polymers have been introduced to the market. Some of these colorants are color-stable with processing temperatures up to 380 °C. If necessary, masterbatches containing these colorants can ensure good covering also with thin wall thicknesses. Hereby, the mechanical properties of glass fiber-reinforced compounds are maintained to a high extent.

In many cases, compromises are necessary when coloring high-performance polymers. Hereby, it must be decided whether an optimum metamerism-free color reproduction or good mechanical properties of the final product has higher priority. All of these points underline the relevance of careful and exact preparation, including a detailed information exchange between the processor or compounder and the manufacturer. Rowa Masterbatch is highly experienced in this field and – with the help of an extensive portfolio of colorants and additives – has created the basis for the development of precisely matched recipes for highly demanding applications in the field of high-performance and engineering plastics. The company offers its customers comprehensive consultation for coloring high-performance polymers (**see Box**). ■

Color Competence Center

In its Color Competence Center (CCC), Rowa has bundled the consultation offers of its company divisions for masterbatches in granulate form (Rowa Masterbatch), finished colored plastics (Romira), liquid colors (Rowasol) and finely dispersed pigment preparations (Rowa Lack). There, in cooperation with customers, the company's color experts develop specific solutions for the respective application area. Thanks to this in-house expertise, all products can be adapted flexibly. In this way, customers obtain a product that provides the best color and consistency for their production and application. The developed products are precisely reproducible. Different color systems such as RAL, NCS, and Pantone are available from the CCC. By means of modern data communication, customers can obtain a color match also without a visual sample, so that the requested color match can be started quickly, and a customized color concentrate or compound can be made available.