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COLOR & APPEARANCE

CAD NEWS®

SPRING 2022 NEWSLETTER

ANTEC 2022 | SAVE THE DATE

CAD RETEC 2022 | CALL FOR PAPERS

MAKE A SPLASH WITH COLOR II

CAD RETEC® 2022

TECHNICAL ARTICLE

BY MARK M. RYAN JR., THE SHEPHERD COLOR COMPANY

CAD NEWS®

SPRING 2022 NEWSLETTER

SPRING 2022 CHAIRMAN'S MESSAGE

Welcome to the 2022 Spring issue of CADNEWS®. As you will notice the CADNEWS® has been newly formatted to bring a more up to date and more relevant Newsletter to our dignified readers. Inside you will find all that the Color and Appearance Division (CAD) is doing and what is coming up in 2022 that will benefit our membership.

So what's coming up in 2022 with CAD. ANTEC 2022 will be held as a hybrid event, with live presentations June 14th – 16th and virtual presentations recorder and presented at a later date. See the information in this issue on times and program for this year's ANTEC. RETEC, as of this writing, is still scheduled as a live event in Orlando, FL at the Renaissance Sea World. This year's event will be a Monday to Wednesday conference starting September 12th and going to the 14th. A strong technical program is being put together and if you feel you have a topic you would like present, there is still room in the program to add you. See the Call for Papers in this issue for details and important dates.

Please look through the sponsorship ads in this issue of the CAD Newsletter. Click on the ads to be taken to the respective website and learn as much as you can about the Color and Appearance of plastics industry you are part of.

I hope you enjoy reading through this Newsletter and as always, if there is something missing or you would like to see in the Newsletter, do not hesitate to let us know and we will see what we can do.

MARK TYLER

Color and Appearance Division Chair | Color and Appearance Newsletter Editor

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SPONSORS

COLORCHEM INTRODUCES NEW TECHNOLOGY FOR THE EV MARKET

ATLANTA, GA-- ColorChem International Corp. is introducing technology to color high-voltage safety components for the EV market. ColorChem is already well-known for its high heat product line comprised of numerous proprietary dyes and pigments for use in coloring polyamides (PA) and other high temperature plastics. From this product line, Amaplast® Orange YXL, Amaplast® Orange GXP, and Amaplast® Yellow NX offer the ideal colorant combination for coloring PA and other high-heat applications that require matching the bright RAL 2003 orange color standard for live, under-the-hood electrical components in EVs.

These Amaplast® dyes offer the superior heat stability (400°C), lightfastness (without UV stabilization), sublimation resistance, and weatherability required to color live components in electric vehicles and other high-performance plastic products. Not only are these colorants strong, bright and cost effective for PA, but they can also be used in other high-heat polymers such as PPS, PSU, PC and polyetherimide.

RAL 2003 orange is becoming the industry standard for safety markers and high voltage components in electric and hybrid vehicles. It is the signal color to alert emergency personnel of high voltage and live components contained under the hood. Electric vehicles require much higher voltages and currents than gas powered vehicles. Voltages can be as high as 400V DC in the battery circuit. Therefore, to reduce the risk of serious accidents, live components need to be easily identified by anyone handling the vehicle. Amaplast® Orange YXL, Amaplast® Orange GXP, and Amaplast® Yellow NX will provide the bright and permanent RAL 2003 orange required to keep emergency personnel safe.

ColorChem International Corp. has been providing the plastics industry with the highest quality dyes and pigments for over 20 years. ColorChem offers a wide range of solvent dyes able to color a variety of plastics, especially those polymers that demand the most thermally stable colorants. Many of ColorChem's products are proprietary colorants—developed by ColorChem's R&D team, headquartered in Atlanta, Georgia and manufactured in either the U.S. or Mexico. In addition to the proprietary high heat dyes for nylon, ColorChem also offers a range of dyes for PET, several UV and IR absorbers, as well as the Neolor™ cerium sulfide pigments.

More information is available at ColorChem.com. To contact ColorChem directly, please email sales@colorchem.com

8601 Dunwoody Place, Bldg 334, Atlanta, GA, USA 30350 Tel: 770-993-5500 Fax: 770-993-4780 www.ColorChem.com

MAKE A SPLASH WITH COLOR II

CAD RETEC® 2022

CALL FOR PAPERS

Renaissance Sea World
Orlando, Florida
September 12th – 14th 2022
(Monday to Wednesday Event)

Abstract and Title due early April.
Papers Due June 15th

Chairperson:	Mark Tyler, Silberline MFG tylerm@silberline.com
Vice Chairperson:	Alex Prosapio, Sudarshan AProsapio@sudarshan.com
Technical Program:	Breeze Briggs, Sun Chemical Breeze.Briggs@sunchemical.com
	Andrew Smith, AErnestConsultech andrewernestsmith@gmail.com

spe CAD RETEC®
Orlando, Florida • September 12-14, 2022
Presented by SPE Color and Appearance Division

ANTEC® 2022 SAVE THE DATE

June 14-15, 2022; Charlotte, NC

ANTEC® showcases the latest advances in industrial, national laboratory and academic work. Papers will share findings in polymer research and/or new and improved products and technologies.

SPE is hosting ANTEC® 2022 in-person, co-located with PLASTEC® South, an Informa event, in Charlotte, NC, June 14-15. PLASTEC® South is a comprehensive annual plastic design and manufacturing event for plastics professionals, suppliers and buyers to discover innovation, engineer new technology, and to expand their networks. ANTEC® 2022 will also include an online component.

The presentations at the in-person event will be selected/invited based on the applicability of their topic across a wide cross-section of the plastics value chain. Presentation/speaker selection, which will occur through a paper submission/review process and/or through invitation, will be considered based on the quality, relevance and newness of any research done in the field as well as the speaker's position in the plastics industry. Technical Papers that are not selected for in-person ANTEC® will be recorded and delivered virtually over a schedule that will be announced soon.

ANNOUNCEMENTS

SPE CAD Scholarship Information Reminder for 2022 / 2023 School Year

The Society of Plastics Engineers Color and Appearance Division have scholarships available for qualified individuals.

Jack Graff Memorial Scholarship	up to $4000.00
Gary Beebe Memorial Scholarship	up to $4000.00
Bob Charvat Memorial Scholarship	up to $4000.00
Steve Goldstein Memorial Scholarship	up to $4000.00
George Rangos Memorial Scholarship	up to $4000.00

Application will open up on **May 2, 2022** | Application Deadline is **June 13, 2022**
For questions on applications or process please email Ann Smeltzer, or call Ann at 412-298-4373

Board of Directors Elections for Color & Appearance Division
VOTING will begin April 11th and end May 9th 2022
Be prepared to VOTE!

Board of Directors Voting

The Color & Appearance Division of the SPE is conducting its annual Board of Directors elections for the term 2022 - 2025. The election is open to current SPE members with CAD as their primary division. Members of the Board participate in the planning, organization and running of CAD activities including ANTEC programs, RETEC programs, Technical Programs, Scholarship Programs & Funding, as well as offering guidance and advice to other SPE members interested in coloring plastic resins.

Visit the **Color & Appearance Division Elections Portal** to vote for your choices.

SPE Color and Appearance Division Mission Statement

The Color and Appearance Division of SPE strives to educate, train, inform and provide professional interaction opportunities to the global community involved in visual performance and aesthetics of plastics.

INVITATION TO ATTEND CAD BOARD MEETING

The Color and Appearance Division (CAD) holds 4 Board of Directors (BOD) meetings each year, either in person or virtually. Any CAD members in good standing with in SPE and has Color and Appearance as their selected division are welcomed to attend these meetings. If interested in attending these meetings, please contact the current CAD Chairperson or any BOD for more information.

CADNEWS® Technical Content – Scott Heitzman

The Technical Content portion of our Spring addition of CADNEWS® includes a best paper from 2016 that was presented at both a RETEC and ANTEC! The paper High Performance Inorganic Pigments: Complex Inorganic Colored Pigments by Mark M. Ryan Jr. is a great introduction to Complex Inorganic Colored Pigments (CICP). The overview or the range of colors is a solid resource.

CADNEWS® Color Notes – Scott Heitzman

Welcome CADNEWS® Color Notes. The idea is to create discussion and provide comments regarding questions you may have related to color and appearance, color measurements, and colorants in general. Do not miss your opportunity to anonymously ask our team of experts a question. Use the link below to submit your questions. Our SPECAD Color Notes committee will provide a response to one or more of the submissions in the upcoming CADNEWS® letter.

http://specad.org/color-questions-for-cad/

TECHNICAL ARTICLE

HIGH PERFORMANCE INORGANIC PIGMENTS: COMPLEX INORGANIC COLORED PIGMENTS

MARK M. RYAN JR., THE SHEPHERD COLOR COMPANY

Abstract

Color is as basic to people as emotions. When we are sad we feel blue, when we're sick we look green and when we're mad we are red under the collar. In fact, our use of color predates even modern humans.[1] Scientists have discovered that humanities ancestors dispersed pigments with an abalone shell and quartz rock into natural resins to produce paints for body adornment and cave paintings- the first DIY home improvement projects. Those earliest pigments were natural ochres. In the ongoing centuries we have expanded our palette of pigments to include synthetic pigments and organic chemistry based pigments. A special branch of this pigmentation are the Complex Inorganic Color Pigments (CICP)s.

Complex Inorganic Color Pigments provide high-performance color for the most demanding applications for plastics and polymers. CICPs can stand up to the most challenging and aggressive processing and applications. Recent advances have found that these pigments have properties that give them the ability to address regulatory requirements and give not only color, but also functional properties.

Introduction

Complex Inorganic Colored Pigments (CICP)s are a specialized sub-section of pigments as can be seen in diagram 1. They are often made from a blend of simple oxides that are then heated in a kiln from about 600 degrees Celsius and higher. At these elevated temperatures the metal ions transfer back and forth so that they are no longer simple oxides, but a matrix of multiple metals and oxygen. In this new chemical form they have new properties and are stable to their firing temperature. The use of controlled atmospheres can affect the oxidation state of the final product and influence color.

An example would be the intimate mixing of a black cobalt oxide with white aluminum oxide and then putting the mixture into a kiln at about 1200C for several hours. When cooled to room temperature they will chemically no longer be cobalt oxide or aluminum oxide, but rather a new chemical, cobalt aluminate (CI Pigment Blue 28)- a bright red shade blue with outstanding stability and low warping characteristics.

The CICPs used in plastics differ mainly from pigments used in ceramics in that they are more finely processed to a lower particle size to increase their tint strength and improve their processing properties. For plastics applications, yellow CICP pigments often have a median particle size of 1-1.5 microns, while blues are usually around 1 micron and blacks pigments are often submicron. These particle sizes are much smaller than the size of the pigment coming off the kiln and are achieved by various milling techniques such as jet mills, ball mills, impingement mills and screening devices. While the chemical make-up of CICPs is the major driver of the color of the pigment, the particle size can also affect the color due to the greater light scattering of CICPs versus other pigment like organic pigments. This particle size and scattering effects can also impact the amount of IR light scattered by pigments when incorporated into plastics.

Diagram of Pigment and Colorant Groups

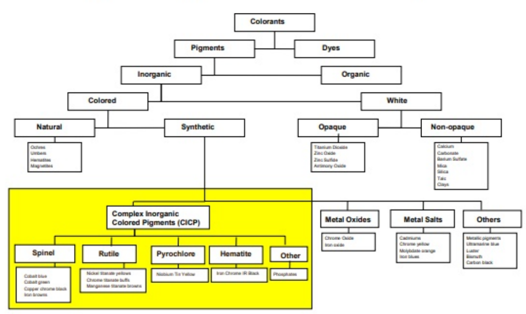

Diagram 1

While in general, inorganic type pigments are among the oldest pigments to have been used by humanity, there still are important innovations and applications in these very versatile family of CICPs.

Objective of Work

The objective of this work is to survey the CICP technology.

1. Explore the properties and benefits of using CICPs.
2. Discuss the range of pigments available.
3. Discuss properties beyond just visually perceived color.

Discussion

Complex Inorganic Color Pigments have a number of interesting properties. The most well known attribute is their high heat stability that stems from their 'ceramic' nature. Many of the CICP pigment chemistries found first commercial use in coloring ceramic bodies, glazing stains or porcelain enamel for metallic substrates. The high temperature stability stemmed from their need to remain stable and insoluble at elevated temperatures in these glassy and sintered binders. This inherent stability led to their use in high-temperature engineering polymers for plastics and coatings.

Pigments used in ceramic applications are often of a fairly coarse particle size to reduce the amount of pigment that may solubilize in the sintering ceramic or molten enamel. Because of the lower temperatures and insolubility in organic binders used in plastics processing relative to ceramic applications, smaller particles with higher surface areas can be used. This reduction in particle size from 5-10 microns to around 1 micron means that the plastics grade CICPs can be used in thin film and fiber applications. At the same time the reduction in particle size increases opacity and hiding power, which increases the tinting strength of the pigment. Opacity increases because the smaller particles are better able to scatter visible wavelengths of light. CICPs, due to their high index of refraction, are inherently good at scattering light. Particle size control and optimization improves upon these properties. As the particle size decreases the surface area increases, which leads to higher tint strength. With most CICP pigments there is a trade-off between masstone color and tint strength. Decreasing particle size leads to higher tint strength but after a certain point the scattering promoted by smaller particles scatters wavelengths of light that do not complement the inherent absorption of the pigment. As this happens the masstone color of the pigment becomes less chromatic and appears washed-out. For most pigments there is an optimum particle size that balances masstone color and tint strength.

While the CICPs scatter light due to their relatively higher index of refraction compared to common polymers, they also selectively absorb light to produce colors. Organic pigments, in general, absorb light through the use of carbon-carbon double bonds conjugated to be tuned to selectively absorb light for a specific color. CICPs, being inorganic, do not have these carbon bonds. Instead the various metal cations are in a stable matrix. While simple oxides like chrome oxide (PG17) and red iron oxide (PR101) are made of one metal, CICPs have more than one. The CICPs form into crystal structures, with common ones being spinel, rutile and hematite. Color arises from the electronic transitions associated with the d-d electron orbitals of the transition metals in the CICP lattice. Doping in of small modifiers into the lattice structure can modify these band gap interactions and give rise to color, or shift the color.

An example of would be the titanate family of pigments. Rutile titanium dioxide (PW6) is largely colorless and scatters light well. It does have some photocatalytic activity when exposed to UV light. Surface coatings to the pigment reduces this degradation mechanism for organic polymers. The titanium can be modified with chrome, nickel or manganese and charge balanced with antimony. While titanium dioxide is white (non-selectively absorbing) the nickel antimony titanate (PY53) is a green-shade yellow, the chrome(III) antimony titanate is a red-shade buff yellow and the manganese antimony titanate (PY164) is a brown. The antimony in each of these can be replaced with niobium and very similar colors are produced. The interesting side effect of changing the electronic structure of the pigments thru the use of the Cr, Ni, and Mn is that they are no longer photocatalytic and do not need surface modification/shells to make highly durable pigments for polymer systems.

Because the CICPs are ceramic in nature, they are fairly abrasive. While direct measurement of the Mohs hardness is difficult to determine, there is anecdotal evidence of their abrasive nature. Titanates in particular are known to be abrasive and induce wear in metallic processing equipment. PY53 (nickel titanate) is particularly sensitive to this because it also has low coloring strength, so any metal or contamination that it scours off can decrease its chromaticity. This abrasiveness also can damage reinforcing fibers in fiber filled plastics, causing a decrease in final material properties.

Because of these inert and robust physical properties that are inherent because of their inorganic nature and high processing temperatures, CICPs are stable in a wide range of acids, bases and resistant to solublization and migration in polymer systems. This inherent stability means that the CICPs gain widespread regulatory approval- especially when the inherent insolubility of the pigments means that they are able to pass leaching and extractable testing. This, along with their non-migratory behavior, means that many of the CICP pigments meet FDA coloring of polymers in food packaging regulations and some are even approved for use in medical devices.

This inert nature also makes the CICPs the standard pigments for high-durability, long-term building products. While simple oxides are also stable, the CICPs have greater color range and chromaticy. While there are no commercial true red CICPs, the simple inorganic oxide red iron (PR101) does have high soluble iron in acid extraction. This free iron can degrade rigid PVC, used in exterior applications for things like window profiles, siding and entry systems. While CICP pigment chemistries have iron as a constituent (PBk30, PBr29), the iron is locked into the pigment structure and is not easily extracted even by concentrated acids at elevated temperatures.

Because of their more complex manufacturing and their high-temperature processing, CICPs are higher priced than simple oxides. CICPs are therefor used in largely special applications where other pigments fail due to heat, UV, chemical or solvent attack.

Range of Pigments

Complex Inorganic pigments come in a wide range of colors, with the notable exception of a true red. They generally lack the ultimate chromaticity of organic pigments but due to higher scattering, they are more opaque. Due to weaker absorption bands, which leads to lower chromaticity, they also tend to have lower tint strengths than organic pigments. Common CICP pigments are:

CI Pigment Black 28 (Copper Chromite): This blue-shade black pigment makes an excellent colorant for engineering and high-temp plastics with temperature stability above 800C. PBk28 pigments have a bluer tone that carbon blacks in masstone and tints, but not as low of a masstone L*. A range of particle sizes are available with larger PSD versions having more jet masstones due to less visual scattering, but lower tint strength. As particle size is reduced, the tint strength increases, but the masstone doesn't appear as jet-black due to visible light scattering. PBK28 provides excellent durability in exterior systems. It does not reflect solar IR energy, so exterior surfaces will be hotter than when made with PBr29 IR reflective blacks, but this can be useful in areas such as laser marking and solar heat collection for water heaters.

CI Pigment Black 26 (Manganese Ferrite): A blue-shade black with higher tint strength and more neutral tone than PBk28. It has a lower heat stability of 600C. It has a very fine basic structure which aggregates to the observed PSD. High shear can break down this structure and shift tint strength. Its primary application is in masstone applications where better heat stability than carbon black is required and a 'chromium-free' option is desired versus the PBk28.

CI Pigment Green 17 Modified (Chromium green-black hematite) and CI Pigment Brown 29 (Chromium Iron Oxide): A designation for a range of compositions of iron and chrome with visually absorbing and near-IR reflecting properties. Modifiers in PG17 to this iron-chrome lattice improve this visibly-absorbing/IR-scattering relationship. PBr29 is another way to designate an iron-chrome pigment that only includes iron and chrome. A major use is in rigid PVC applications to reduce deformation from solar induced heat build-up in building products and other applications like wood-plastic composite decking. While it contains iron, it is bound up in the lattice structure and is not readily soluble and therefore can be used in PVC. Recent years have seen the expansion of its use from PVC to other building materials to reduce deformation and meet regulatory and building code solar reflectivity requirements.

CI Pigment Black 30 (Chrome Iron Nickel Black Spinel): A very jet black with solar reflective properties. It has lower near-IR reflectance than the PG17 and PBr29 IR blacks, but with much higher tint strength and more neutral tints with white. PBk30 is a work-horse in the PVC industry. Though it does contain iron, it is bound up in the CICP lattice and the relatively low solubility and low-use rates due to high tint strength making it suitable for off-white rigid PVC applications. Excellent heat stability over 800C.

CI Pigment Green 50 (Cobalt titanate): A range of yellow-shade green pigments that is more chromatic than standard chrome oxide green (PG17). Good stability in a wide range of systems and non-warping in polyolefins.

CI Pigment Green 26 (Cobalt Chromite): A muted blue-shade-green color that is used to match military specifications where exact curves in the near-IR are necessary to match natural foliage when viewed with night-vision equipment. It is useful for matching dark Hunter Green type shades that will weather more consistently rather than blending a blue and yellow, with different weathering properties.

CI Pigment Green 17 (Modified Chrome Oxide): A dark green color used to match new generation near-IR camo. These modified chrome oxides are darker than standard chrome oxides and do not have a cobalt absorption band that PG26 exhibits starting at around 1300nm.

CI Pigment Blue 28 (Cobalt Lithium Aluminate): A light, bright pastel shade blue color known best for coloring food containers due to its low warping characteristics in polyolefins.

CI Pigment Blue 36 (Cobalt Chromite Blue Green Spinel): A variation of the PBl36 chemistry that has a turquoise color.

CI Pigment Blue 36 (Cobalt Chrome(III) Aluminate): A dark green-shade blue with excellent dispersion and stability. Non –warping and stable to over 800C.

CI Pigment Blue 28(Cobalt Aluminate): A bright red-shade blue with excellent dispersion and heat stability that resists warping in polyolefins. Not as red toned as PBl29 (Ultramarine Blue), but with higher heat stability and resistance to acids and overall weathering stability.

CI Pigment Yellow 227 (Niobium Tin Pyrochlore): An extremely high-chroma yellow pigment near in color space to Lead Chromate (PY34). It has good heat stability (>320C) and resistance to acids and bases. There is no silica shell to wear off in processing. An excellent alternative to PY34 in high-performance applications. Besides the chromatic masstone, it has excellent opacity and hiding along with strong tint strength.

CI Pigment Yellow 216 & CI Pigment Orange 82 (Rutile Tin Zinc): Much higher chromaticity than PBr24, PY216 has evolved to be a true orange pigment. Useful in matching oranges, it also makes an excellent way to add redness to other pigments like PY184 (Bismuth Vanadate) and PY227 (NTP Yellow) and retain an all inorganic pigment mixture for optimal stability.

CI Pigment Yellow 53 (Nickel Antimony Titanate): A green-shade yellow that has excellent durability and heat stability (>800C). Relatively weak in tint strength and lower in chromaticity than PY184. It makes an excellent high temperature yellow as part of lead chromate replacement in conjunction with PY227.

CI Pigment Brown 24 (Chrome Antimony Titanate): A red-shade buff yellow with excellent heat (>800C), chemical, solvent and weathering resistance. Useful in engineering polymers where organic and zinc ferrite pigments do not have high enough heat stability. Iron free so it can be used in rigid PVC. PBr24 in conjunction with PY164 (Manganese Titanate), IR Blacks (PBr29 or PBk30), Chrome Oxide green (PG17) and Nickel Titanate (PY53) make an excellent color palette for rigid PVC applications.

CI Pigment Brown 33 (Zinc Iron Chromite Brown Spinel): The reddest shades of CICPs browns available.

CI Pigment Black 12 (Iron Titanium Chromite Brown): A tan to brown pigment with excellent stability and high tint strength. More heat stable than zinc ferrite pigments but less chromatic than PBr24. Higher tint strength than PBr24 makes it an economical option if it can reach the required color space. Useful in artificial turf applications because it is zinc free for areas concerned with run off. Contains iron that has some solubility so PVC systems need to be checked for performance.

CI Pigment Yellow 164 (Manganese Antimony Titanate): A dark shade brown with good stability and dispersion. Being iron free, it is useful in rigid PVC applications for building materials since red iron oxide can't be used.

Properties Beyond Visual Color

The color of a pigment is the prime attribute by which we judge the utility of a pigment. CICPs, by their inherent nature and properties can exhibit beneficial properties beyond selectively absorbing and scattering visible wavelengths of light to give the impression of color. Two of these functional benefits are the inclusion of CICPs into a number of direct food contact approval lists around the world and the near IR reflectivity of visually absorbing pigments.

FDA Food Contact Approved CICP Pigments

CICP Pigments are excellent pigments for FDA food contact applications because of their high heat, acid and base stability along with their low migration and solubility. There is also increased interest in FDA status of colorants beyond typical food applications. Many entities in the marketplace are seeing the FDA status as a kind of 'safe' label.

Due to changes in the Food Drug and Cosmetic Act (FD&C Act), new approvals for food contact are specifically granted to a pigment chemistry produced by a specific pigment producer.[2] No longer are generic pigment classes, denoted by CI Pigment number, approved across all producers. A colorant producer now receives Food Contact Notification (FCN) based on a CAS number subject to controlled production methods, with the same raw materials, and meet purity requirements laid out by the FDA. Title 21 CFR 178.3297 lays out definitions and provisions that the FCN is subject to.

There are two new useful approvals to the palette of CICP pigments in the black and blue color ranges.

The first is in the black color space and is a very useful tool in coloring high temperature cookware. PBk26 is a jetter and 'chrome-free' alternative to the commonly used PBk 28 (Copper Chromite) based pigments. With a small particle size and strong visible absorption the pigment produces deep masstone black colors that are also heat stable to around 600 degrees Celsius, depending on the system that it is used in.

The second pigment is a Green-shade blue PBl36 (Cobalt Chrome Aluminate). Red-shade blue PBl28 (Cobalt Aluminate) has been approved for food contact approvals for years, but PBl36 is subject to a Food Contact Notification opens up a new color space for CICP pigments in food contact applications. With a deep, dark masstone and a strong, vibrant tint the new addition bridges the gap between the aforementioned red-shade blues and the PG50 (Cobalt Titanate) pigments.

A summary of what CICP pigments are approved for food contact applications and the limitations on use are seen in Diagram 2. Regulations do change, so seek expert help for any clarifications.

World Food Contact Approvals

CI Pigment	JHOPSA Positives List	GB9685-2008 Chinese Listings and Approvals: Plastics	GB9685-2008 Chinese Listings and Approvals: Coatings	AP(89)1[J]	BfR[K]
Violet 16					
Brown 24	D	2%[I]		Approved	Approved
Black 28		5%[H]		Approved	Approved
Blue 28	D	As Needed[F]	As Needed	Approved	Approved
Blue 28	D	As Needed[F]	As Needed	Approved	Approved
Green 50	D	2%[I]	As Needed	Approved	Approved
Yellow 53	D	1%[F]	As Needed	Approved	Approved
Blue 36		3%[I]		Approved	Approved
Black 26				Approved	Approved
Special Effect				Approved	Approved
Green 17	E			Approved	Approved
Yellow 216				Approved	Approved

A) Food Contact Notification (FCN) 000938 B) Food Contact Notification (FCN) 000868 C) Food Contact Notification (FCN) 000430 D)For use in PE, PP, PS, AS, ABS, PA,PET,PC, POM and PBT plastics
E) For use in PP and PE plastics. F) Max use in PE, PP, PS, AS, ABS, PA, PET, PC, PVC, PVDC and UP. H)Max use in PE, PP, PS, AS, ABS, PA, PET and PVC. I) Max use in PE, PP, PS, AS, ABS, PA, PET and PC

J) Council of Europe AP(89)1 Approved Pigments - migration of the elements antimony, arsenic, barium, cadmium, chromium, lead, mercury, and selenium from the following pigments are typically below the limits set forth in the Council of Europe's resolution AP(89)1 on the use of colourants in plastic materials coming into contact with food, 13 September 1989.

K) BfR Approved Pigments: Pigments are not regulated by the Bundesinstitut für Risikobewertung (BfR) unless they contain dangerous substances. The listed Shepherd pigments and others variants pigments do not require BfR registration.

This chart is meant as a quick guide to food contact approvals. Additional products may met these regulatory approvals. Please see notes below and contact Shepherd Color for more specific information.

Diagram 2: Food contact application approvals

Advances and Specialization in IR Reflective Black CICPs

Infrared reflective pigments have been used for decades in various applications. The use of CICPs based on chromium-iron oxide type pigments (PG17mod and PBr29) really started with their use in the early 1980s to keep PVC substrates from being deformed and degraded when exposed to sunlight.[3] These chromium-iron oxide pigments have matured into a wide range of pigments for specialized applications not only in building products but also in a myriad of other applications where solar induced heating of plastics can cause issues or IR reflectivity for specialized applications like counterfeit detection.

First, a brief summary of these chromium-iron oxide pigments and why they are so useful. While our eyes are only sensitive to wavelengths of light from about 400-700nm, the sun's spectrum extends beyond this narrow range. Roughly half of the sun's energy is in the visible (400-700nm) while the other half is in the near-infrared (700-2500nm) with a few percent in the highly damaging 295-400nm UV range. A black pigment has to absorb in the visible range for color, and most continue this absorption into the near-infrared. Chromium-iron oxide based black pigments absorb in the visible so that they are dark in color, but around 700nm they start to reflect. When we look at the total solar range of 295-2500nm, a standard black (PBk7) has a Total Solar Reflectance (TSR) of 5% (or 0.05) while the chromium-iron oxide pigments (PBr29) would have around a TSR of 28% (or 0.28). This TSR can be read by a spectrophotometer. The effectiveness of the pigments can also be tested by using a device that will show the difference in heating a test panel that contains different pigments.

The original use in plastics for the chromium-iron oxide pigments was in light tints in common PVC siding colors. The masstone color was not utilized and the pigment's tint strength was the main differentiator. Progress was made by increasing the processing of the pigments by milling them to finer and finer particle sizes, thus driving the tint strength higher.

By the late 1990s, programs like the EPA Energy Star and later USGBC LEED program and California Energy Commission's Title 24 building code, among others, added reflectivity requirements for steep-slope roofing. The EPA's Energy Star roofing requirement of a TSR of 25% became a common definition of a 'cool roof'. Initially, the chromium-iron oxide pigments used in tint applications were used to meet the reflectivity standards, but consumer preference for darker and jetter blacks was not met by these pigments. While their tint strength had been optimized by reducing particle size, this also increased scattering in the visible wavelengths making the masstone take a lighter and redder tone, yielding a very dark brown color.

The marketplace preference for more neutral tones drove the development of new IR-blacks comprised of the iron-chrome chemistry. Bluer-shade blacks with TSRs of around 25% filled this need. At this point the market for these IR blacks is divided into masstone optimized blue-shade blacks and warmer tone products with higher tint strength.

The IR Reflective blacks continue to be one of the 'hottest' topics in pigments today. The chromium-iron oxide pigments are the workhorses that provide high IR reflectance, durability, economical use and a broad range of properties that can be tailored to specific applications.

Conclusions

Complex Inorganic Color Pigments (CICPs) provide specialized properties for the most demanding applications. Their heat stability, inertness, weather-stability and ease of dispersion make them the best option when other coloring pigments fail. Besides these coloristic properties, the CICP family of pigments, because of their inert nature, finds wide regulatory approval as seen in the FDA direct food contact listings. The CICPs also have interesting near-IR properties that make them useful in building products and signal management for military camouflage.

While inorganic pigments have been used since the caveman era, advances continue as seen in the new NTP Yellow (PY227) and improved RTZ Orange (PY216). New pigment chemistries and applications continue to be found.

References

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Milliken presents

Milliken: The Color Experts

Milliken & Company understands the power and value of color as it relates to branding. Humans are visual creatures, and color plays a key role in purchasing decisions, as it helps to inform, personalize and speak the brand language.

The company continues to tap into its vast experience in this space to develop solutions for a wide variety of end markets and end-use applications.

Milliken's color journey began in 1964, when it launched its proprietary Versatint® washable colorants for textile identification. In 1981, it introduced its Reactint® range of colorants for polyurethane (PU). Five years later, Milliken unveiled its ClearTint™ polymeric colorants for use in NX® UltraClear™ polypropylene (PP), which can be made only with its Millad® NX® 8000 clarifier.

The year 2019 marked a major step forward, with the introduction of both its KeyPlast® products, as well as its KeyPlast RESIST™ high-performance colorants for plastics.

Milliken technology helps to color a vast range of sectors, including agriculture and turf; automotive and transportation; building and construction; coatings, paints and inks; home and laundry care; and plastics.

Milliken's KeyPlast RESIST colorants address another key challenge — coloring high-performance engineering polymers with bright and vibrant hues. These colorant are used in the high demanding applications such as high voltage connectors, control systems, structural parts and metal replacement.

Using KeyPlast RESIST colorants compounders and resin producers, offer a vast spectrum of stable and reproducible colors suitable for use with a wide range of resins such as Polyamides, PPA's, Poly Sulphones and other high heat polymer blends and alloys.

Additionally, Milliken continues to keep its finger on the pulse of end-user and market trends, which it documents each year in its ColorDirection report that forecasts the key shades and hues for the coming year. In doing so, it offers a palette of carefully curated colors, while providing the stories behind the inspiration and motivation driving their popularity. Brand owners can leverage this expert information to help capture the mood of consumers through effective branding and personalization.

Milliken's diverse portfolio of colorants can enable product makers to realize their aims to deliver on those colors that will help drive and shape consumer preferences in the coming year.

From the R&D lab to the production floor, Milliken's Chemical Division stands ready to help customers leverage color to design new products, reinvigorate existing products, and create opportunities to grow in new markets and applications.

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