COLORING THE WORLD OF PLASTICS

SUMMER 2015

SPE®
SOCIETY OF PLASTICS ENGINEERS
COLOR & APPEARANCE DIVISION

CAD NEWS™
Published by The Color and Appearance Division of the Society of Plastics Engineers

Chairman's Message

Dear SPE Color and Appearance Division Members,

Welcome to the Summer Edition of CAD News! Hopefully many of you are enjoying the warmer temperatures.

To start, I want to take a moment to remember Dr. Steve Goldstein. Sadly, Steve passed away in the early summer. Steve's contributions to Color and Appearance Division were numerous. He joined the CAD Board of Directors in 1999 and was part of the Technical Resource and Education Committees. During his tenure, Steve gave several papers and, more recently, focused his efforts on compiling and editing content for the "Specifications and Test Methods" seminar. His input, experience, and advice for CAD and the BOD was of great benefit to all of us. While Steve's presence and guidance will be dearly missed, we will continue to benefit from what he gave for many years.

On behalf of the Color & Appearance Division Board of Directors, I'd like to express thanks to Betty Puckerin for her leadership of CAD over the past year. During Betty's term, CAD has been awarded the Pinnacle Gold Award and Communications Excellence Award again. In addition, the CAD portion of ANTEC® and the 2014 CAD RETEC® event were very successful during this time. These events provide essential forums and papers that demonstrate the value, research, and discoveries that influence our part of plastics into new areas.

We also thank Sandra Davis for her time as the CAD Councilor to SPE. Sandra served two terms and represented our Division's ideals, values, and goals in council meetings. Sandra will continue to serve on the CAD BOD as an elected member and continue her contributions on several committees. Bruce Mulholland will undertake the role of Councilor, having been elected to this position earlier this year.

Our most recent CAD board meeting was in

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Color and Appearance Division

Chairman's Message (continued)

early August. We met in Milwaukee, a site for a possible future RETEC®. During this session, we finished most planning for 2015 SPE CAD RETEC® and welcomed new additions to the board. Michael Willis, Alex Prosapio, and Bruce Clatworthy are newly elected members to the CAD board and will serve three-year terms. These meetings serve as outlets for discussions and decisions for all matters of CAD and its associated events. Anyone who wishes to attend should contact a board member.

This fall, we will host the 2015 SPE CAD RETEC® at the Westin Indianapolis on October 4-6. This will be the 53rd RETEC® and we will be joined by the Inter-Society Color Council (ISCC). Co-chairs Betty Puckerin and Scott Heitzman have organized the main conference, venue, and activities. Jack Ladson and Thomas Chirayil have assembled a technical program of quality papers and presentations for the benefit of all attendees.

This year's RETEC® features the return of the Interactive Panel Discussion, moderated by Jeff Drusda, and the New Technology Forum for Exhibitors, headed by Sandra Davis. Also, the pre-conference seminar, Coloring of Plastics, will resume with Bruce Mulholland as the presenter. The annual Golf Outing and 5K Fun Run/Walk will take place as well. Tabletop exhibits registrations are accepted until September 4 (limited availability afterward). Corporate sponsorships are still available with Silver, Gold, and Platinum levels. Check our website at www.specad.org or contact a board member for all 2015 RETEC details.

The RETEC® event serves as the premier forum for the coloration of plastics. This three-day session offers interaction and information for all marketers, sales, suppliers, processors, and stylists of the plastics color industry. The 2014 RETEC® in New Orleans drew 452 registrants and hosted a record 66 exhibitors, and 2015 promises similar numbers. The professional networking offered is a substantial benefit to all participants, as does the collaboration with ISCC. CAD RETEC® 2015 is the largest technical conference in North America that is specifically dedicated to the color and appearance of plastics. Proceeds from RETEC® are used to support scholarships and continuing educations for the students and professionals of our industry.

Best regards,

Jeffrey S. Drusda
2015-2016 SPE CAD Chair

Invitation to Attend Our Board Meetings

The Color and Appearance Division regularly holds Board of Director (BOD) meetings at the ANTEC® and the CAD RETEC®. In addition, a Summer BOD meeting is typically held about 6 weeks prior to the next CAD RETEC®.

The Summer meeting is scheduled in various locations. A Winter BOD meeting is held in January.
The Winter meeting is typically held at a site of a future CAD RETEC®.

Any SPE CAD members who wish to attend are welcome at these meetings. If interested in attending the next Board meeting, please contact the Division Chairperson for more information.

SPE Color & Appearance Division Mission Statement

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

Newsletter Sponsorship Opportunity

The Color and Appearance Division (CAD) commits to the publishing of at least three newsletters a year *(four, if there is sufficient material to justify the extra issue)*. Each newsletter is electronically distributed to our membership of nearly 1,000. Each sponsor's art directly links to the company's website.

In addition, we print one of these newsletters on 80#gloss coated stock, All electronic versions are also posted on the SPE website where it available for anyone to download.

For the small donation of $300 per year, we offer a business card sized (2 x 3.5 inches) mention in our newsletter,

We currently have the following slots available for sponsorship:
(2) 2 x 3.5 inch or (1) 4 x 3.5 inch

If interested in learning more, please contact:
Scott Aumann Phone: 912.210.0175
Email: scott.aumann@emdgroup.com

Board Minutes

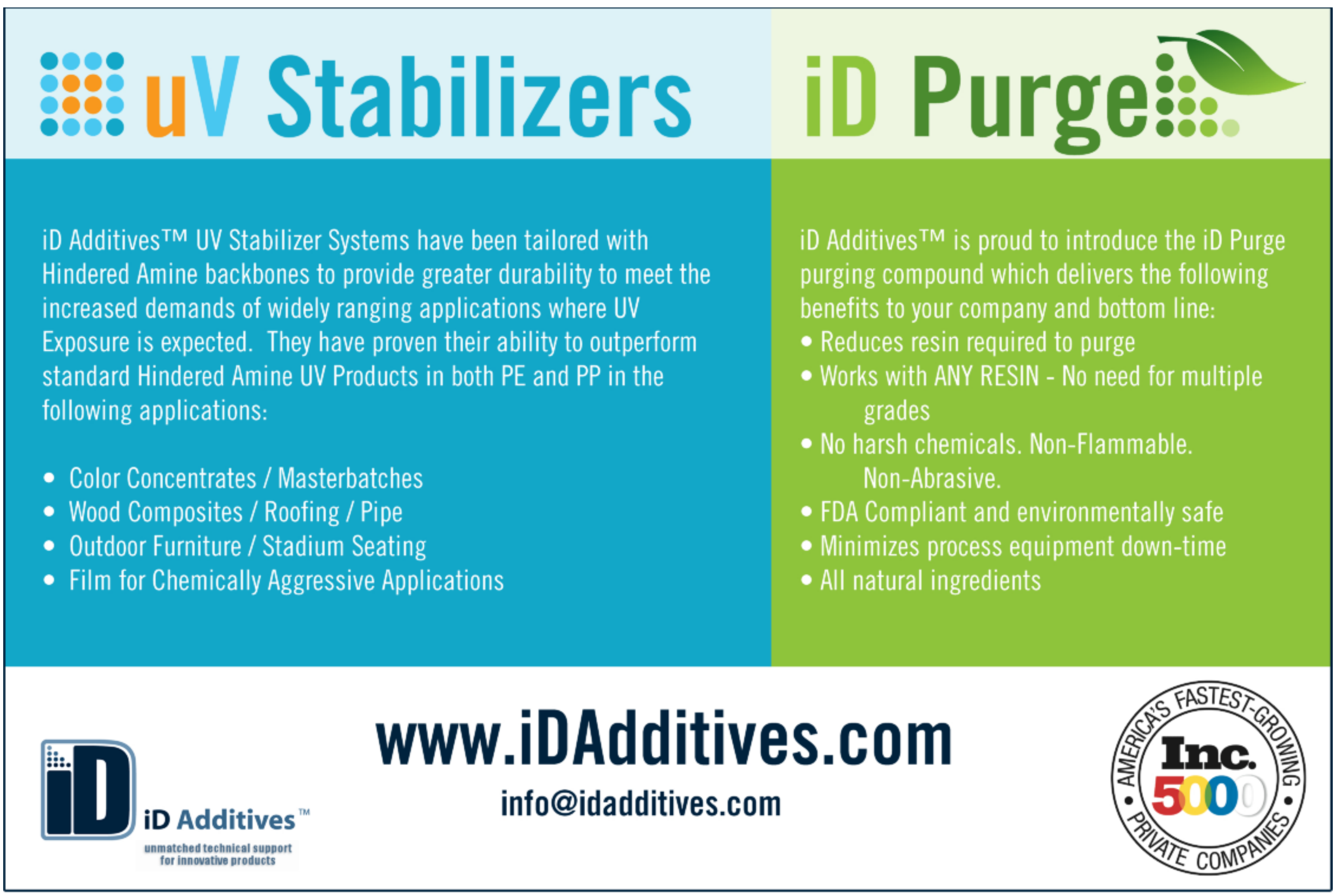
Dear Members:

Just a reminder that you can view past and current BOARD MINUTES on the SPECAD website.

We do not typically publish the minutes in the electronic versions of our newsletter, but they are always available for our members to view from our website.

Also, our Treasurer's Report is listed in the minutes as an attachment. All available on the link below.

Click here for the link to view:
http://www.specad.org/index.php?navid=28



CAD RETEC® 2015 October 4-6, 2015

Hotel & Conference Registration

THE WESTIN INDIANAPOLIS
50 South Capitol Ave..

To Reserve Hotel Online click here - ONLINE HOTEL RESERVATIONS

Indianapolis, IN 46204, United States
Phone: (1) (317) 262-8100
Toll Free: 800-916-4339

GROUP RATE AVAILABLE UNTIL SEPTEMBER 2, 2015.
(SUBJECT TO AVAILABILITY)
Discounted Conference. Room Rate: $165/night-single occupancy
$165/night-double occupancy
Room Block Dates: Oct 4-7

Rates will increase significantly after September 2, 2015 at 5pm or whenever the room block is full.
Cancellation policy: Any hotel reservation canceled within 48 hours of arrival date will be charged for one (1) night\'s room and tax.

Hospitality Suite Reservations:
Please contact conference chair Betty Puckerin (betty.puckerin@axxxampacet.com) for information about hospitality suite reservations. (remove the xxx from Betty's email address prior to sending)

Important Note to Attendees:
Be sure to stay at the conference hotel if possible. Meeting our contracted number of rooms helps defer the cost of meeting space and registration fees and helps us obtain lower room rates of the attendees. Make sure your room and hospitality suites are part of the CAD RETEC® 2015 room block. Thanks for your support and cooperation.

Transporation Information
Closest Airport: IND - Indianapolis

GPS Users: Note that the hotel address(50 S Capital Ave) takes you to the side entrance of the hotel.

SPECAD RETEC® 2015 Airport Shuttle
GO Green Airport Shuttle
Hours: 8:00AM-11:00PM, 7 days a week
One Way: $10/person

To BOOK SHUTTLE click here

The 53rd Annual Society of Plastics Engineers Color and Appearance Division CAD RETEC® *"Winning with Color"* will be held in Indianapolis. We will be joined by members of the Inter-Society Color Council, ISCC, which is an organization that shares our dedication to color education and communication. Their contribution to the conference promises to enrich the technical program and includes speakers: Dr. Ellen Carter, Dr. Michael Brill, Dr. Danny Rich, John Seymour *"The Math Guy"*, Dr. Zhiling Xu, Dr. Francoise Viénot, and Dr. Renzo Shamey. CAD RETEC® 2015 is the world's largest technical conference in North America that is specifically dedicated to the color and appearance of plastics.

WINNING WITH COLOR INDIANAPOLIS CAD RETEC® 2015

INTER-SOCIETY COLOR COUNCIL, INC. FOUNDED 1931 SCIENCE • ART • INDUSTRY

The Westin Indianapolis, Indianapolis Indiana
OCTOBER 4-6, 2015

CONFERENCE REGISTRATION

	EARLY REGISTRATION By 9/4/15	REGISTRATION After S 9/4/15
❐ **SPE Member/ISCC Member** Must include valid SPE e-mail address with registration	$340	$440
❐ **SPE Non-Member Registration** - *Includes 1 Year Membership* Membership will be processed after RETEC®.	$490	$590
❐ **SPE Non-Member Registration Without SPE Membership** Conference registration, but decline the One Year SPE membership.	$550	$650

OTHER REGISTRATION TYPES:

❐ **Speaker/Moderator Registration** Must be a speaker or moderator at the conference for this registration type. This does not include New Technology Forum Speakers.	$170	
❐ **SPE Emeritus Member Registration** Option available for SPE Emeritus Members	$100	
❐ **Student Registration** Must have valid Student ID	$ 50	
❐ **SPE Membership Renewal** Renew your existing SPE membership. Requires SPE membership e-mail address to ensure continued membership status. Note membership renewal may not be processed until after RETEC®.	$109	

*Each registration includes One Conference CD or flash drive containing all papers

EXHIBITORS AND SPONSORS ONLY

❐ **Tabletop Exhibit Space (subject to availability)** Includes two free conference registrations with tabletop. Provide names and titles of both attendees in the appropriate fields at the end of this form.	$950	$1,175
❐ **Sponsor Donation**	Platinum, Gold, Silver (inquire)	

EXTRA CONFERENCE LITERATURE:

❐ **Additional Copy Conference Proceedings** $115 X ____ = $________
Additional CAD RETEC® 2015 conference proceedings download pass.
One copy is already included with each paid registration.

❐ **SPE CAD Archive DVD (1961 - 2007) and** $175 X ____ = $________
Color Papers from 1961-2007 ANTEC® & RETEC® *available on-site*
Special RETEC® Offer: $175 (must also register for the RETEC® conference).
*Savings from the regular price of $200 for SPE members and $300 for non-members.

OTHER EVENT REGISTRATION/RSVP:

❐ **Sunday Golf Outing** $105 X ____ = $________
Sunday golf outing at TPC Louisiana. If registering more than yourself for golf, please include their names using the tabletop names & titles fields at the bottom of the registration page. This will allow you to list up to four names using those fields.

❐ **5K Fun Run/Walk** $20 X ____ = $________
Sign up for Tuesday AM 5K Fun Run/Walk. Proceeds go to Habitat for Humanity

❐ **Coloring of Plastics Tutorial/Seminar (Sunday)** $490 X ____ = $________

Total due from all items checked : $________________

* Refunds less a $30 fee August 16 to September 5, 2015
* No refunds after September 5, 2015
* SPE Memberships are processed after RETEC®

SPE® SOCIETY OF PLASTICS ENGINEERS

If paying by credit card, fax to: 859-372-6382, or e-mail to: bruce.mulholland@ticona.com
REGISTER ONLINE AT: www.specad.org

CAD RETEC® REGISTRANT FORM (Please Print):

SPE Membership #:________________________________

Address: ________________________________
____
____

Country of Citizenship: ________________________

Email: ________________________________

Daytime Phone: ____________________________

Date: ________________________________

Name: ________________________________

Title: ________________________________

Company: ______________________________

For Credit Card Payments Only:

Circle One: AMEX VISA MasterCard
Card No: ______________________________
Expiration Date: ______________________________
Name on card *(if different from above)*:____________________

Signature: ______________________________

If paying by credit card, fax to: 859-372-6382, or e-mail to: bruce.mulholland@ticona.com
REGISTER ONLINE AT: www.specad.org

CAD RETEC® 2015

October 4 – October 6 Indianapolis, IN

Sponsored by the Color & Appearance Division of SPE

Mail-in/fax/email tabletop registration form to Bruce Mulholland

TABLETOP REGISTRATION

ADVANCED REGISTRATION DEADLINE: SEPT, 4, 2015

❑ Tabletop registration (by 09/04/15) $ 950

❑ Tabletop after 09/04/15 $1,175

Tabletops include two full conference registrations.

EXTRA CONFERENCE LITERATURE:

❑ Extra RETEC® 2015 $115 x ___ = $______

❑ Archive DVD (1961-2007) $175 x ___ = $______

(Available on site)

Membership Renewal

❑ SPE membership dues renewal $109

OTHER EVENTS REGISTRATION/RSVP

(MARK RESPONSE/INDICATE QUANTITY)

❑ Opening Reception (Sunday) RSVP: Yes No FREE

❑ Awards Lunch (Tuesday) RSVP: Yes No FREE

❑ Golf Outing (Sunday): $ 105 x ____ = $______

❑ 5K Fun Walk (Tuesday): $ 20 x ____ = $______

❑ “Coloring of Plastics” Tutorial $ 490 x ____ = $______

Total due from all items checked above: $______

Payment Methods

If paying by credit card, fax to: 859-372-6382, or

E-mail to: bruce.mulholland@ticona.com

Mail this form with check payable to the SPE CAD to:

Bruce Mulholland
Celanese
8040 Dixie Highway
Florence, KY 41042

* Refunds less a $30 fee August 22 to September 18, 2015

* No refunds after September 18, 2015

* SPE Memberships are processed after RETEC®

Circle answers below:

Is this your first CAD RETEC®? Yes No

If no, have you attended a CAD RETEC® in the last five years?
Yes No

1st REGISTRANT INFORMATION (Please Print):

SPE Membership #: ________________________

Name: ___________________________________

Title: ____________________________________

Company: ________________________________

Address: _________________________________

____

____

Citizenship:_______________________________

Email:___________________________________

Daytime Phone: ___________________________

2nd REGISTRANT INFORMATION (Please Print):

SPE Membership #: ________________________

Name: ___________________________________

Title: ____________________________________

Company: ________________________________

Address: _________________________________

____

____

Citizenship:_______________________________

Email:___________________________________

Daytime Phone: ___________________________

For Credit Card Payments Only:

Circle One: AMEX VISA MasterCard

Card No: _________________________________

Expiration Date: ___________

Name on card (if different from above):

____

Signature:_________________________________

Date: ______________________

For checks, make in US dollars only payable to: “SPE CAD”

October 4, 2015

The Brickyard Crossing is one of the most unique golf courses in the world. Located on the grounds of the famed Indianapolis Motor Speedway the lay out features four holes actually inside the famed oval and has hosted tour events for all three major professional tours.

RETEC®2015 GOLF OUTING INFORMATION

Voted One of Americas Top 100 Public Golf Courses by Golf Digest and Golfweek and designed by noted golf course designer Pete Dye

Course Location
Brickyard Crossing
4400 West 16th St.
Indianapolis, IN 46222
(317) 492-6417

Registration: 10:30 am - Noon (EST)

Shotgun Start: 12 Noon (EST)
Taylormade rental clubs are available for $70.00 per set. Includes 2 sleeves of Logo golf balls. Indicate you will need clubs and shaft preference when you register or let us know and we will take care of it.

Awards: Will be presented at CAD RETEC® Welcoming Reception

Price: $105.00 per golfer

Includes:
- Warm up on the Range
- Green Fees
- Cart Fee
- Awards (hole prizes)
- Box Lunch with Drink
- Scramble format

To Sign Up: Online Registration

Questions Contact:

Mark Tyler

mark.tyler@celanese.com 859.372.3221 or

Mark Freshwater

mark@pigments.com 201.665.0091

CAD RETEC® Preliminary Schedule & Technical Program

(Subject to Change – Check website for current details)

Sunday, October 4

PRE-CONFERENCE SEMINAR: 8:30am – 5:00pm
Coloring of Plastics with Bruce Mulholland. *(Separate Registration required)*

GOLF OUTING 10:30am – 4:00pm *(Pre-register for this event)*
BRICKYARD CROSSING GOLF CLUB
10:00am – Registration at course
12:00 – Noon shotgun start *(Lunch will be provided before teeing off)*
4 person scramble format
$105 Fee. See page 9 for details. Golf Outing Prizes will be presented at the Welcome Reception.

2:00pm – 6:00pm **Registration Desk Open**

1:00pm – 5:30pm **Exhibitor Set Up**

8:00pm – 10:00pm **Welcome Reception**
(Pick up your registration packet prior to this event to get your complimentary drink coupons)
Music: Color Eye Band
Welcome Reception Sponsors: A. Schulman and EMD Chemicals

Monday, October 5

7:30am Breakfast *Sponsor: Lansco Colors*
7:30 Registration desk opens
8:15 Introduction & Welcome by Tom Rachal

MORNING SESSION - GRAND 5

Moderator: Cheryl Treat, A. Schulman

8:00 Opening Remarks *Betty Puckerin, Ampacet, Scott Heitzman, Sun Chemical, Dr, Ellen Carter, ISCC*
8:30 Keynote 3D Printing: The Disruptive Technology
Ron Beck, Americhem
9:30 Heat Stability & Compatibility of Dyestuff with Engineering Plastics.
Breeze Briggs, BASF
10:00 Coffee Break *(Exhibits Open) Sponsor: Clariant*
10:30 Manipulation of Polymer Refractive Index to Achieve Highly Chromatic Colors in ASA Polymers
Steven Blazey, A. Schulman
11:00 What is the Shape of a Color-Tolerance Surface
Dr. Michael H. Brill, Datacolor, ISCC
11:30 Enforcing Constraints in the Kubelka-Munk Calculations
Paul Centore - Consultant
12:00 LUNCH *On your own*

AFTERNOON SESSION - GRAND 5

Moderator: Earl Balthazar, Datacolor

1:30 Panel Discussion: Color Trend for 2016 and Beyond
Moderator: Jeff Drusda, *Silberline*
Panelists: Doreen Becker, *A. Schulman,* Linda Carroll, *Ampacet,* George Ianuzzi, *Sudarshan* and Dr. Danny Rich, *Sun Chemical*.
3:00 Coffee Break *Sponsor: Kronos*
3:30 An Analysis of the Thermochromism Properties of Colored PVC Tiles for the Precise Color Measurement of Composite Materials
Jiangning Che & Muditha Senanayake
4:00 Creating Appearance with Pigments and Polymers
Romesh Kumar, Clariant
4:30 Will Color Engineering Ever Be a Reality
Dr. Danny Rich, Sun Chemical, ISCC
5:00 New Technology Forum
Moderator: Sandra Davis, The Chemours Company
6:30 Networking Reception GRAND 1-4 *Sponsor: Nubiola*

Tuesday, October 6

7:00am 5K Fun Run/Walk for Habitat for Humanity Plastics
(Pre-register for this event)
Sponsor: Dominion Colour

MORNING SESSION - GRAND 5

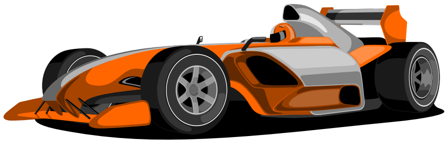
Moderator: Jack Ladson, Color Science Consultancy

8:30 Keynote Address Patenting a Color
John Seymour, "The Math Guy" ISCC
9:00 Second-order-diffraction Correction in Spectrophotometry
Dr. Zhiling Xu & Dr. Michael H. Brill, Datacolor & ISCC
9:30 Coffee Break *Sponsor: The Chemours Company*
10:00 Natural Photo-Initiators and Oxidation Reactions in Natural Materials
Denise Connors, The Chemours Company
10:30 Color Vision Fundamentals: A Model for the Future of Colorimetr *Dr. Francoise Vienot, Museum National d'History Naturelle, ISCC Award Recipient, ISCC*
11:30 Awards Luncheon *Sponsor: Tronox*

AFTERNOON SESSION - GRAND 5

Moderator: Jim Rediske, BASF

1:30 The Influence of Ultraviolet Absorbers on the Color of Plastics
Tad Finnegan, BASF
2:00 New Pigment Developments for Plastics Industry
Mark Vincent, Dominion Colour Corp
2:30 Accelerated Weathering Testing for the 21st Century
Sean Fowler, Q-Lab Corporation
3:00 Coffee Break *Sponsor: Shepherd Color*
3:30 Supra Threshold - Small Color Differences
Dr. Renzo Shamey, NC State, ISCC
4:00 Processing Mica-Based Pigments
Rob Roden, Steer World
4:30 Closing Remarks - BETTY PUCKERIN, AMPACET
Survey Raffle - MC: TRACY PHILLIPS, UNIFORM COLOR COMPANY
GRAND PRIZES: GOPRO HERO4 CAMERA
OTHER PRIZES- TBD (MUST BE PRESENT TO WIN)



Thank you RETEC® 2015 Sponsors!

WE ARE PROUD TO HIGHLIGHT THESE EXCELLENT COMPANIES.
Please visit our generous sponsors' websites by clicking on their logos below.

Platinum Level Sponsors

- BASF – The Chemical Company
- LANSCO COLORS
- STEER®
- SunChemical® – a member of the DIC group

Gold Level Sponsors

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- M.HOLLAND – THE GOLD STANDARD IN PLASTICS
- LANXESS – Energizing Chemistry
- SILBERLINE® – The Global Supplier of Effect Pigments™
- SPECTRA – HIGH PERFORMANCE COLORS FOR PLASTICS

CAD RETEC® 2015 Exhibitors

1. Leistritz
2. Fortune Int'l
3. Lubrizol
4. TrustChem
5. TrustChem
6. Agrofert
7. HL Blachford
8. Coperion
9. Shepherd
10. Dayglo
11. Capelle
12. 3V
13. Huntsman Pigments
14. Huntsman TiO2
15. Apex
16. ID Additives
17. Sun Chemical
18. Silberline
19. Heucotech
20. Brenntag
21. Tomatec
22. Aakash
23. PCC Chemax
24. Steer America
25. BASF
26. BASF
27. Brabender Technologies
28. Dominon Color
29. The Chemours Co.
30. United Mineral And Chemical Co.
31. Applied Marketing Information
32. Modern Dispersions Inc
33. CINIC
34. Eckart
35. Nubiola
36. Tronox LLC
37. Paramount
38. Sincol
39. Datacolor
40. CQV Co., LTD
41. Clariant
42. Clariant
43. Clariant
44. Welset
45. The Cary Company
46. Lanxess
47. Maroon
48. EMD
49. Lanxess
50. Lanxess
51. Yipin Pigments, Inc
52. OMYA
53. FP Pigments
54. Tronox

Exhibitors Booths as of 9/1/15

In Memoriam – Steven Goldstein

Dr. Steven Ira Goldstein, 59, of Rutland, died unexpectedly on Friday, June 26, 2015 in Charlotte, NC, while on a business trip. Dr. Goldstein was born in Bronx, NY, the son of Edward and Beatrice (Neufeld) Goldstein. He was raised in Lindenhurst, NY and later lived in Latham, NY and Charlotte, NC before moving to Rutland in 2012.

Dr. Goldstein leaves his loving wife of 34 years, Roberta (Zimmerman) Goldstein of Rutland; his mother, Barbara Goldstein of West Palm Beach, FL; three sons, Zachary and his wife, Laurie Knaack of Castleton, NY, Max of Charlotte, NC, and Alex who is posted in South Korea; a sister, Deborah Salerno and her husband, Nicholas of Merrick, NY; a brother, David Gorin of Merrick, NY; a sister, Leah Edzant and her husband, Robert of San Diego, CA; his uncle, Buddy Bert Neufeld of New York, NY; and several nieces and nephews. He was predeceased by a son, Jordan Matthew Goldstein. After earning his B.S. in Chemistry at Long Island University, he went on to earn his M.S. in Chemistry at SUNY Buffalo where he met Roberta, and then received his Ph.D. in Chemistry at Emory University.

Dr. Goldstein was the technical director for Clariant Masterbatches North America. He was responsible for all research and development activities across Clariants 11 sites in the United States and Canada. In addition, he was widely recognized as a plastics industry expert, serving on the Board of Directors for the Color and Appearance Division of the Society of Plastics Engineers. Previous to Clariant, Dr. Goldstein enjoyed 22 years with BASF working with colorants and additives for plastics.

Among his many interests were fantasy and science fiction books, tabletop gaming, the New York Yankees, comics and other collectibles. He enjoyed nothing more than spending time with his family, traveling with Roberta and sharing hobbies with his sons. He was a loving husband, father, son and brother.

source:http://www.milesfuneralhome.com/sitemaker/sites/MilesF1/obit.cgi?user=70775519_DGoldstein

Call for Papers-ANTEC® 2016 – Indianapolis
May 23 - 25, 2016

The Color and Appearance Division is currently looking for paper submissions for next year's ANTEC® which will be held in the same location as our RETEC® conference next month.

Ladies and Gentlemen: Start Your Engines!

Encompassed by the excitement of the impending 100th running of the Indy 500 race - and surrounded by industries working with plastics - ANTEC® 2016 in Indianapolis is destined to be a high energy event! Join SPE as we cover topics such as *Plastics Enabling the Car of the Future* and continue our explorations into the world of 3D printing.

Contact Tom Chirayil for details regarding details on how to submit a paper which will be represented by our division or if you have any questions about the process: thomas.chirayil@xxxbasf.com *(remove xxx after ampersand before emailing)*

Click here for more info about ANTEC®2016!

CAD BOARD 2016-2019

The Color & Appearance Division is calling for nominations of interested and qualified SPE members to serve on our Board of Diretors in the upcoming term. This is a great opportunity to serve the industry and for it to serve you with professional networking. Share your expertise and ideas to help promote SPE, the industry, and your company. Qualified nominees will run in the upcoming elections. Terms are a 3 year commitment.

If you or someone you know would like to serve on the board, please contact Brenda Mullins Brenda.mullins@xxxclariant.com *(remove xxx after ampersand before emailing)*

Connect With SPE CAD Via Social Media

Linked in®

Join SPECAD's Group On Linked In

to network with industry peers, participate in group discussions of industry and technical topics, find job opportunities, and get the latest division and conference announcements.

Group Name: SPE Color & Appearance Division
Group ID 152108
www.linkedin.com/groups?gid=152108

Technical Article

INORGANIC PIGMENTS: FROM CAVEMAN TO THE 21ST CENTURY
COMPLEX INORGANIC COLORED PIGMENTS

Mark M. Ryan Jr.,Marketing Manager, The Shepherd Color Co.

ABSTRACT
We surround ourselves with color. In fact, our use of color predates even modern humans. Scientists have discovered that our ancestors, ***Homo helmei,*** dispersed pigments with an abalone shell and quartz rock into natural resins to produce paints for body adornment.[1] Those earliest pigments were natural ochres. In the intervening eons we have expanded our palette of pigments to include synthetic pigments and organic chemistry based pigments. Still a stalwart of performance are the inorganic pigments and this paper surveys a specific class of these pigments called Complex Inorganic Color Pigments (CICPs).

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

BACKGROUND
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 one or more metal 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 a few 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 smaller 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 black 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 affect the color also due to the greater scattering of CICPs versus other pigments like organic pigments. This particle size and scattering effects can also impact the amount of IR light scattered by pigments when incorporated into plastics

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 the very versatile family of CICPs.

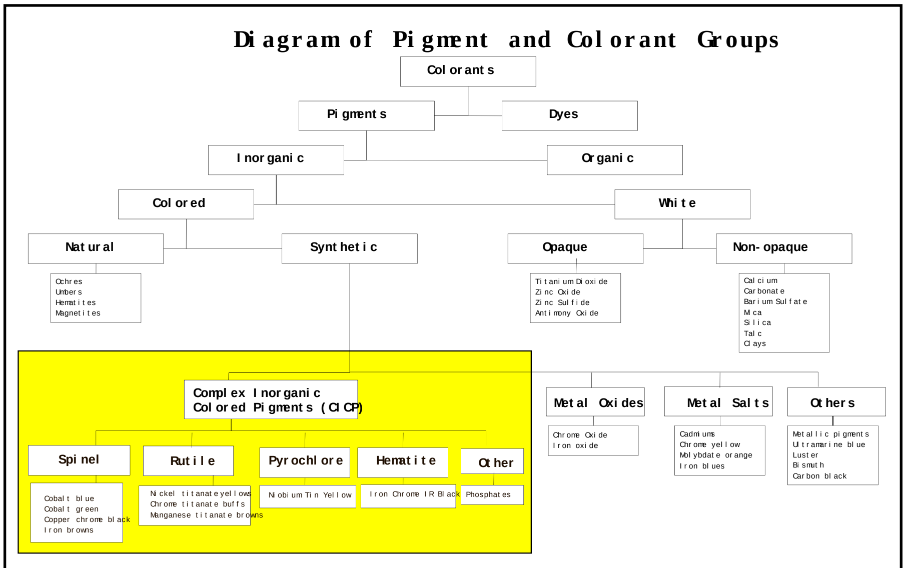

Diagram 1

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 visual color.

DISCUSSION

Complex Inorganic Color Pigments have a number of interesting properties. The most common 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. 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 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 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 delectron 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 base 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 solubilization and migration in polymer systems. This inherent stability means that 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 direct food contact 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

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commercial true red CICPs, red iron oxide (PR101) does have high soluble iron in acid extraction. This free iron can degrade polymers, especially rigid PVC, used in exterior applications for things like window profiles, siding and entry systems.

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 lead 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 a 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 jetter 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. PBK28 provides excellent durability in exterior systems.

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.

CI Pigment Green 17 Modified *(Chromium green-black hematite)*: A designation for a range of compositions of iron and chrome with visually absorbing and near-IR reflecting properties. Modifiers to this iron-chrome lattice improve this relationship. Finds use in rigid PVC applications to reduce deformation from solar induced heat build-up in building products. 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 requirements.

CI Pigment Brown 29 *(Chromium Iron Oxide):* PBr29 is another way to designate an iron-chrome pigment that only includes iron and chrome. Similar in performance and properties to the PG17 designated IR Blacks.

CI Pigment Black 30 *(Chrome Iron Nickel Black Spinel):* A very jet black with solar reflective properties. 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 has low solubility making it suitable for 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.

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 display starting at around 1300nm.

CI Pigment Blue 28 (*Cobalt Lithium Aluminate):* A light, bright pastel shade blue color known best for coloring food containers.

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.

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CI Pigment Yellow 227 *(Niobium Tin Pyrochore):* 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 *(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. Contains iron that has some solubility so PVC systems need to be checked for performance.

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 runoff.

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. A PBk26 known in the market place as Black 20F944 is a jetter 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 known in the market place as Shepherd Color Blue 10F545 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.

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World Food Contact Approvals

CI Pigment	JHOPSA Positives List	GB9685-2008 Chinese Listings and Approvals: Plastics	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

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 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.

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 will only reflect about 5% of the sun's total energy, while a chromium-iron oxide based IR black will reflect in the mid-to-high 20%. We say that the standard black has a Total Solar Reflectance (TSR) of 5% (or 0.05) while the chromium-iron oxide pigments 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 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 finerparticle 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 steepslope 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 chromiumiron 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.

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