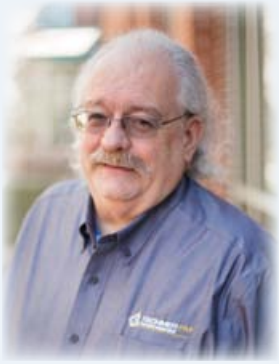
Summer 2018

CAD NEWS

A publication of the Color and Appearance Division of the Society of Plastics Engineers

Dear SPE CAD members,



I'm back. Yes, it is an honor and privilege to be your Chairman, again! First I'd like to thank our outgoing chair Cheryl and the entire team for a great 2017-2018 year. The 2017 RETEC® and 2018 ANTEC® were very successful. Income from RETEC®s allow us to fulfill our ongoing commitment to education, our primary mission. So let me say once again it was a real Treat working the 2017-2018 team.

I mentioned this was my second time around as chairman and although most folks are happy to have the experience just once, I'm having a second go. People ask me didn't you learn your lesson the first time? But seriously, we had a retirement in the progression of the chairs and it is very difficult for someone to come in mid-stream as you need that prior experience to move up. Also, at my age this would be my last opportunity to do so. How I got into the progression the first time is an interesting story that I'm saving for a future issue.

CAD RETEC® is fast approaching and is the premier conference for the Color and Appearance of plastics with great talks, panels, exhibits, and of course networking. This is our 56th RETEC® and the dates are September 23-25, 2018, at the Charleston Airport Convention Center. Response has been great so far. If you haven't booked rooms yet you will be in the overflow hotel as the host hotel is sold out so better get a move on.

Sunday offers a tutorial on color or you could attend the golf tournament. The Conference kicks off Sunday night with the opening reception. Monday starts out with a Sponsored Breakfast followed by the day's technical program ending with the New Technology Forum and Networking reception. Tuesday continues the technical program punctuated by the awards luncheon where we recognize individual volunteer's achievements, awards earned by the Division and recognition of our corporate sponsors.

Looking forward to seeing you all there and there are more details elsewhere in this issue.

Best Regards,
Brian West
Chairman

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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.

Editor's Note

Welcome to the Summer issue of the Color and Appearance Division Newsletter where I hope you find pertinent information on the events upcoming and subjects of interest to you.

We are about a month away from this year's RETEC® in Charleston SC *(September 23rd–25th)* where we have an excellent technical program set up as usual. There will also be a panel discussion on weathering of plastics on Monday morning as well as keynotes and presentations around this topic so make sure you are there to ask your questions on anything you would like to know about the weathering of plastics. Sunday evening starting at 8:00 will be the opening reception where Color Eye Blind will be playing and networking opportunities all around. The host hotel is providing us two busses to take people downtown Sunday and Monday evenings to enjoy the sights and tastes of Charleston without the worry of driving. There will be more information provided as we get closer to RETEC® but wanted to get the word out that there will transportation opportunities provided.

There will be over 60 companies exhibiting at this year's event to show off their products and any new products or systems that they are launching this year. They will have representatives there to answer your questions about their products and be able to demonstrate their new technologies. Make it a point to visit the exhibits and engage the people at the show and see what they can do for you. Also, along with the exhibitors there will be the New Technology Forum Monday after the afternoon sessions where a company will have 5 minutes to discuss new products that they may be launching. It is a great opportunity to see what's new in the industry and who to talk to about it.

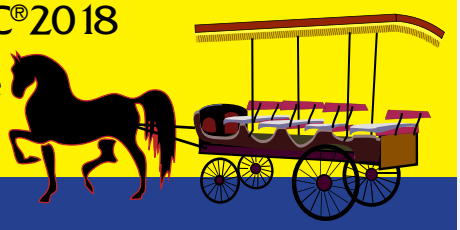
A quick reminder that 2019 ANTEC® is early this year, March 18th to the 21st in Detroit, so that moves all deadline dates ahead from paper submissions to elections to the BOD for this division. See the information in this Newsletter for details on submission deadlines and consider participating as a presenter at next year's ANTEC® or being part of the CAD BOD.

Some of the extra events going on for RETEC® is the Golf Outing at Wild Dunes Links Course (preregister) on Sunday Morning, Coloring of Plastics Tutorial (preregister) Sunday Morning, Networking Reception Monday after New Technology Forum, and the Fun Run (preregister) on Tuesday morning.

We hope to see you at RETEC® 2018 in Charleston. You don't want to miss it. A reminder that early registration discounts end Friday September 7th so to save $100 on the registration fees you need to register by then.

Mark Tyler
Color and Appearance Newsletter Editor
mark.tyler@celanese.com

CAD RETEC®2018 Committee



CONFERENCE CHAIR:
Breeze.Briggs, BASF
Breeze.Briggs@basf.com

CONFERENCE VICE-CHAIR:
Brenda Outlaw ,BASF
Brenda.Outlaw@basf.com

TECHNICAL PROGRAM CO-CHAIRS
Jeff Drusda,The Chemours Company
jeffrey.drusda@chemours.com
Alex Prosapio, Sudarshan
aprosapio@sudarshan.com

WEATHERING PANEL DISCUSSION:
Jack Ladson, Color Science Consultancy
jack@ColorScienceConsultancy.com

EXHIBITOR CHAIR:
Brain West, Techmer PM
Bwest@techmerpm.com

NEW TECHNOLOGY FORUM:
Scott Heitzman, Sun Chemical
scott.heitzman@sunchemical.com

REGISTRATION CHAIR:
Bruce Mulholland, Celenese
bruce.mulholland@celanese.com

SPONSORSHIP CHAIR:
Cheryl Treat, BASF
Cheryl.Treat@basf.com

PAPER DOWNLOADS:
Sharon Ehr, Uniform Color Company
sehr@uniformcolor.com

PRINTING/PUBLICITY
Betty Puckerin, Ampacet
Betty.puckerin@ampacet.com

WEBSITE:
Jeff Drusda,The Chemours Company

FUN RUN/WALK:
Bruce Howie, Dominion Colour Corporation

GOLF OUTING:
Mark Tyler, Celenese

RAFFLE:
Chuck DePew, Holland Colours

The next eight pages are dedicated to information about RETEC®2018.

There is still time to save $100 on the conference but the deadline is September 7th!

As is the deadline for the overflow hotel (Doubletree at the North Charleston Convertion Center).

CAD RETEC® 2018 Sponsors

Registration fees for attendees are kept low in part by the generous donations of corporate and individual sponsors. We'd like to say a special thanks to these generous sponsors and recognize their support of the conference. Watch for sponsorship signs during the conference to see which event each of the companies below sponsored.

Platinum Level Sponsors

AAKASH CHEMICALS
THE SKY
IS THE LIMIT

COLORS & EFFECTS | BASF We create chemistry

EMD Performance Materials

DCC LANSCO pigments.com

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Shepherd
The Shepherd Color Company
We Brighten Lives

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DCC LANSCO pigments.com

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The chemistry inside innovation®

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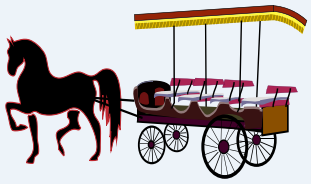
Energizing Chemistry

SILBERLINE
The Architects of Light™

2018 CAD RETEC® Tabletop Exhibitors



Exhibitor	Location
3V Sigma USA	C
Aakash Chemicals	C
Applied Market Information LLC	C
Arrow Point Corp	C
BASF Corporation	Foyer
Birla Carbon	C
Brabender Technologie	C
BYK-Gardner USA	C
Chemigon	C
Chemours	C
Paramount Colors, Inc.	C
CINIC Chemicals America, LLC	C
Clariant Corporation	Foyer
Coperion Corporation	C
C.W. Brabender Instruments, Inc	C
DataColor	C
Day-Glo Color Corporation	C
DCC LANSCO	C
Eckart America Corporation	C
EMD Performance Materials	Foyer
ENTEK	C
Ferro Corporation	C
Fortune International Technology	C
FP-Pigments, Inc.	C
Heucotech LTD	C
HL Blachford Ltd.	C
HunterLab	C
Intercoastal Sales	C
Keim Additec Surface USA, LLC	C
Konica Minolta Sensing America	C

Exhibitor	Location
Kuncai Americas LLC	C
Lanxess Corporation	Foyer
Leistritz	C
Liberty Specialty Chemicals	C
Lintech International LLC	C
Lomon Billions	C
Lubrizol	C
M. Holland	C
Maroon Group LLC	C
Milliken & Company	C
Modern Dispersions Inc.	C
Omya, Inc.	C
Royce Associates ALP	C
Sandream Impact LL	C
Sanhu Color	C
Schlenk Metallic Pigments	C
Shepherd Color Company	C
Silberline Manufacturing Co.	C
Sincol USA Inc.	C
Spectra Dyestuffs Inc.	C
Sudarshan North America	C
Sun Chemical Corporation	Foyer
TOMATEC America, Inc.	C
Torrecid USA	C
Tronox LLC	C
Trust Chem USA, LLC	C
United Mineral & Chemical Corp.	C
Venator	C
Yipin Pigments Inc.	C
Zeppelin Systems	C

SPE Events App: Download from iTunes or the Play Store
No login or password required!

GOLF OUTING
SUNDAY, SEPTEMBER 23RD

The Links Course at Wild Dunes Resort

If anyone is interested in playing Saturday before the Outing, please let us know and we'll see if anything is going on. When registering, after your name input your typical 18 hole or 9 hole score. Please behonest to make this fair.

Schedule (EST)
Registration: 11:00am to 12:15
12:30 pm Shotgun Start

Course Location
1 Sundial Circle
Isle of Palms, SC 29451
Phone: (866) 359.5593

Scramble format
Teams will be drawn based on handicaps this year.

Price:
$105.00 per golfer
Includes: Range, Green & Cart Fees, Lunch

Wild Dunes Charleston's Island Resort

click on logo above to go to course website

Questions Contact:
Mark Tyler (859) 372.3221 or
Mark Freshwater (201) 665.0091 or
Alex Prosapio (845) 641-0506

HOSPITALITY SUITES

While hospitality suites are not sponsored by the SPE CAD, we realize the importance of these functions to the conference attendees.
Check hotel monitors and signs for times and locations of other suites operating during CAD RETEC® 2018

Bus to Charleston: Sponsored by: Kronos

SHUTTLE BUS TO DOWNTOWN
Sunday: 4:00 – 8:00 p.m.
Monday: 7:00 – 11:00 p.m.

Need your CAD RETEC® badge to ride.
See signage for pick-up locations.

WELCOME RECEPTION
Sponsored by: EMD Chemicals

BALLROOM B
SUNDAY, SEPTEMBER 23RD
8:00PM – 11:00PM

JOIN US FOR COCKTAILS, NETWORKING, LIGHT SNACKS, AND LIVE MUSIC BY COLOR EYE BLIND WITH SPECIAL GUESTS

COMPLIMENTARY WITH REGISTRATION
USE THE GREEN DRINK TICKETS.

EXHIBIT SCHEDULE

BALLROOM C AND FOYER
MONDAY, SEPTEMBER 24
10:00AM – 7:00PM

NETWORKING RECEPTION
MONDAY, SEPTEMBER 24
6:00 PM – 7:00P M

TUESDAY, SEPTEMBER 25
8:30 AM – 3:00 PM

CHARGING STATIONS

SPONSORED BY
TOMATEC AND
SANDREAM IMPACT

CHARGE YOUR DEVICE AT ONE OF THE STATIONS IN THE EXHIBIT AREA

MONDAY BREAKFAST

MONDAY, SEPTEMBER 24

7:00AM IN BALLROOM B

SPONSORED BY

DCC LANSCO

COMPLIMENTARY WITH REGISTRATION!

MONDAY LUNCH

MONDAY, SEPTEMBER 24

12:00PM IN BALLROOM B

SPONSORED BY

SANHU COLOR

COMPLIMENTARY WITH REGISTRATION!

NETWORKING RECEPTION

MONDAY, SEPTEMBER 24

6:00PM - 7:00 PM IN BALLROOM C AND FOYER

SPONSORED BY

SHEPHERD COLOR

USE THE GOLD TICKETS FOR DRINKS.

COMPLIMENTARY WITH REGISTRATION!

5K Fun Run/Walk
To benefit Habitat for Humanity

TUESDAY, SEPTEMBER 25TH

HOTEL LOBBY AT 7:00AM

Start your Tuesday morning off right. Join us bright and early for a fun run/walk through North Charleston. You'll be back in time to catch the first paper.

Event Sponsor: DCC LANSCO

Event Coordinator: Bruce Howie

Cost: $20

CAD will match your donation!

AWARDS LUNCHEON

BALLROOM B

TUESDAY, SEPTEMBER 25TH

11:30 PM – 1:30 PM

SPONSORED BY

TRONOX LLC

COMPLIMENTARY WITH REGISTRATION

CAD SURVEY RAFFLE:

BALLROOM A

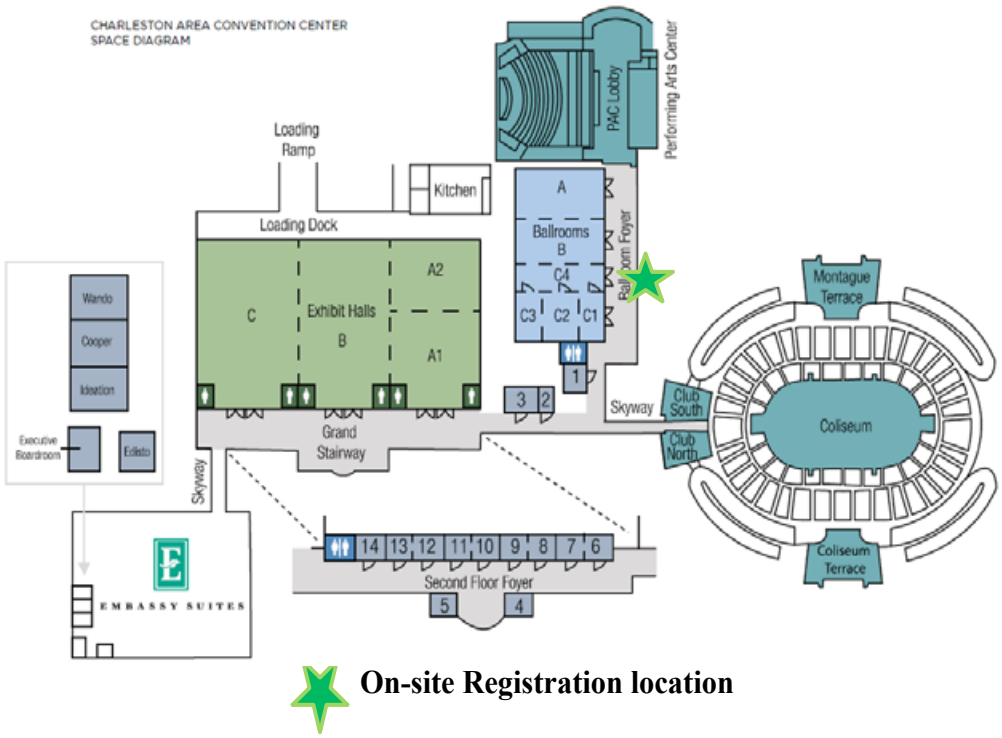
TUESDAY, SEPTEMBER 25TH

4:00 PM

Complete your survey and drop it off at the Registration Desk for your chance to win.

Grand Prize: Amazon Echo Spot plus many other great prizes!

* Must be present to win *



On-site Registration location

designed to **enhance** design

Colorants, additives and effects formulated to enrich plastics applications and processes.

Ampacet

660 White Plains Road, Tarrytown, NY 10591 914.631.6600 www.ampacet.com

SPE CAD RETEC® Coloring of Plastics Tutorial
Sunday, September 23rd

The Color and Appearance Division of SPE has been presenting the "Coloring of Plastics" tutorial at the start of the CAD RETEC® conference for many years. Many SPE members and non-members have benefited from this program. The tutorial is a great starting point for those just beginning a career, or an excellent continuing improvement opportunity to those who wish to add to their base knowledge of coloring of plastics. The course is full of practical information which is embellished and enlightened by the active participation of all the attendees.

The tutorial runs a full day on Sunday prior to CAD RETEC® and does require a separate registration and fee. The attendance is limited to 20 persons, so register soon. Attendees receive a full-color manual to use as a reference when they return home.

Who might benefit from attending the tutorial?

Executives needing to better understand their company's coloring issues

Managers newly appointed and/or desiring to communicate more effectively with peers and subordinates

Color formulators/matchers to better understand the theory behind their work

Color specifiers/approvers to understand limitations in coloring of plastics

Sales personnel hoping to gain more technical knowledge to better serve their customers

Product designers wishing to better understand the technology behind the coloring of plastics, to make better and more informed decisions

Color manufacturing personnel to understand the impact of compounding on color

Color processors *(injection molding, extrusion, etc)* to better understand the technology ways they can impact the final color

Attendees will leave the course with a better understanding of color technology and should be more effective in their careers around color.

For more information about Color of Plastics Tutorial, please contact the Tutorial Instructor
Bruce Mulholland @ bruce.mulholland@celanese.com or call 859-525-4765

To register for this opportunity please visit the SPECAD Website

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CAD RETEC® 2018 Technical Program
Special Super Session
Monday, September 24th

Weathering Session & Panel Discussion
Monday, September 24, 2018 from 8:30 am to 12:00 pm

CAD RETEC® 2018 will include a Weathering/UV session designed to bring together technical experts in UV test equipment, additive suppliers, formulators, and end users. The impressive array of speakers is developed to foster understanding and discussion of weathering of plastics. Check out the technical program for all of the details.

Color and appearance are important factors when designing plastic materials and parts. For many demanding applications, it is not only the initial color and appearance that are important, but maintaining that good appearance over time when exposed to environmental conditions of temperature, UV energy, and moisture. Attend the session to learn more about this important topic. This Weathering/UV session is designed for colorant suppliers, additive suppliers, formulators, material scientists, laboratory management, quality control personnel and end users – all those who have an interest in this area of expertise.

Thanks to Jack Ladson for coordinating this year's special session!

SPE CAD RETEC® 2018

Technical Program

Monday • September 24th 2018

Ballroom A

		Speaker/Company, Sponsor	Title
Moderator:	**Mark Tyler, Celanese**		
7:00-8:00 AM	Breakfast	DCC LANSCO	Ballroom B
8:15	Opening Remarks	Breeze Briggs, *BASF*	Welcome to CAD RETEC® 2018 in Charleston, SC
8:30	Keynote	Andy Francis, *Qlab*	Temperature Control During Fluorescent UV Weathering Testing of Plastic Materials
9:00	Paper	Al Zielnek, *Atlas/Ametek*	Environmental Exposure of Plastics – Factors Which Can Affect Color and Appearance
9:30	Paper	Yuta Ozeki, *SUGA*	Effectiveness of Ultra-high, Accelerated Weathering Test Methods
10:00	Break	Sun Chemical	
10:30	Panel Discussion	Moderator: Jack Ladson, *Color Science Consultancy*	**Panel Discussion Topic**: Weathering of Plastics Andy Francis, *Qlab,* Bruce Mulholland, *Celanese*, Tad Finnegan, *BASF,* and Al Zielnek, *Atlas/Ametek*
Noon	Networking Lunch	Sanhu Colors	Ballroom B
Moderator:	**Todd McHenry, Lanxess Corporation**		
1:30	Paper	Christof Kujat	What's up Doc in the Red Color Space?
2:00	Paper	Karl "Hendrik" Schluckebier *Zeppelin*	High Performance Mixing for Color Concentrates
2:30	Paper	John Seymour, *John The Math Guy, LLC*	Statistical Process Control of Color
3:00	Break	Chemours	
3:30	Paper	Todd Waddle, *M Holland*	Market & Color Industry - Trends & Impact
4:00	Paper	Nigel Smith - *Lansco/DCC*	Organic Pigments – How Environmental and Regulatory Challenges Shape the Present and Our Future
4:30	New Technology Forum	Moderator: Scott Heitzman *Sun Chemical*	See separate schedule
6:00	Networking Reception	Shepherd Colors	Ballroom C & Foyer

SPE CAD RETEC® 2018

Technical Program

Tuesday • September 25th 2018

Ballroom A

		Speaker/Company, Sponsor	Title
Moderator:	**Mark Freshwater, DCC LANSCO**		
8:00 AM	Welcome - Day 2	Breeze Briggs, *BASF*	
8:00	Keynote	Doreen Becker, *Ampacet*	Design Strategies for Sustainable Pigmented Plastics
8:30	Paper	Don Connolly, *New Castle Consultancy*	Six Things That You Should NEVER Do When Handling TiO_2
9:00	Paper	Neil MacDonald, *Lomon Billions*	A discussion of the Maufacturer and Properties of Titanium Dioxide Pigments for Plastics Applications
9:30	**Break**	**Clariant**	
10:00	Paper	Tad Finnegan, *BASF*	The Influence of Additives on Polymer Discoloration
10:30	Paper	Mahesh Metteloo, *Sudarshan*	Dispersion Study of Pigments Using the Thermo Kinetic Mixers
11:30	Paper	Christopher Thelen, *Sudarshan*	A Modest Proposal For Establishment of Global Regulatory Standards
Noon	**Awards Luncheon**	**Tronox**	**Ballroom B**
Moderator:	**Earl Balthazar, Datacolor**		
1:30	Paper	Arno Boehm, *Colorflex*	Functional Additives in Plastics Processing – Next Generation NIR Absorbers and Colorants for Plastics Laser Welding
2:00	Paper	Arno Boehm, *Colorflex*	Functional Plastics in LED Lighting – Efficient Thermal Management in Lightly Colored and Transparent Plastics Parts
2:30	**Break**	**TrustChem**	
3:00	Keynote	Christopher Beier, *Clariant*	Electronic Structure and Photochemistry of Pigments: The Chemistry of Color and Durability
3:30	Paper	Mark Ryan *Shepherd*	Weathering of Polymers with Colored Inorganic Pigments: Results and Considerations
4:00	**Closing Remarks/ Raffle**	Breeze Briggs, Brenda Outlaw	

speakers and schedule subject to change

ANTEC®2019
DETROIT | MARCH 18-21
DETROIT MARRIOTT AT
THE RENAISSANCE CENTER

click on logo above to go to ANTEC®2019 website for submission details and form

Color & Appearance Division

CALL FOR PAPERS

ANTEC® is the world's largest plastics technical conference.

A full manuscript submission is required and will be due by October 19, 2018. Your paper will be published as part of the ANTEC® 2019 proceedings.

The Color & Appearance Division will be holding our annual technical sessions during this conference and would like to encourage you and your company to participate by presenting a paper. We would consider any paper related to the color and/or appearance of plastic and the following categories would be typical topics:

- Color Trends
- Decorative or Special Effects
- Color Measurement
- Color Matching Techniques
- Instrumentation/Test Methods/Quality Control
- Stabilization of Color
- Materials (Colorants, Additives, Plastics)
- Property Retention/Durability
- Troubleshooting or Innovation in the Color Area
- Regulatory Issues
- Processing and Equipment
- Other Color/Appearance Related Topics

Plastics industry professionals who submit papers at ANTEC® 2019 have a choice between two tracks: technical or commercial. The technical track includes more traditional ANTEC® papers, which address new technologies and techniques currently in development in the plastics industry. The commercial track is for papers that speak to commercial applications of these technologies and techniques, and can be similar to a case study.

For more information visit the CAD website or contact ANTEC® 2019 CAD Technical Program Chairs

Breeze Briggs	Cheryl Treat	Petty Puckerin
248-304-5303	313-570-3911	812-466-9828

COLOR & APPEARANCE

CALL FOR CANDIDATES

Color & Appearance Division Board of Directors 2019 to 2022

The Color & Appearance Division of the SPE will be conducting its annual Board of Directors elections. The election is open to current SPE members with CAD as their primary division. Time commitment would be for four meetings per year for 3 year terms. Two of the meetings will correspond with ANTEC® and RETEC® where you will participate in CAD activities and initiatives. 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.

INSPIRING PLASTICS PROFESSIONALS

WE NEED YOUR HELP – CONTINUE THE EXCELLENCE!

- Interested candidates for the 2019 Board of Directors should contact Doreen Becker any Board Member, or indicate your interest on the questionnaire
- We will be soliciting candidates through the end of November, 2018
- Biographies due December 14, 2018
- Elections start in January, 2019 and run throughout the month
- If elected, term is 3 years (serve until 2022)
- There are 4 Board meetings per year to attend: ANTEC®, CAD RETEC®, Winter, and Summer meetings

To be listed as a candidate or have questions about becoming a candidate, please call or Email:
Doreen Becker, Ampacet
PH: 914-769-1679
Doreen.becker@ampacet.com

SPE CAD RETEC® 2019 - CALL FOR PAPERS
Renaissance Cleveland Hotel
Cleveland, Ohio
September 23 – 25, 2019 (Monday – Wednesday format)

Deadline for Abstracts is February 2019

Chairperson: Steve Esker, Paramount Colors
steve@paramountchemicals.com

Technical Program: Ann Smeltzer, Clariant,
ann.smeltzer@clariant.com
Alex Prosapio, Sudarshan,
aprosapio@sudarshan.com

Society of Plastics Engineers
Color & Appearance Division
Endowment Scholarship Program
for the 2019 – 2020 School Year

The Endowment Scholarship Program offered by the Color & Appearance Division of the Society of Plastics Engineers awards multiple scholarships each year to students who have demonstrated or expressed an interest in the coloring of plastics industry. The students must be majoring in or taking courses that would be beneficial to a career in this industry. This would include, but is not limited to, plastics engineering, polymer science, coloring of plastics, chemistry, physics, chemical engineering, mechanical engineering, industrial design and industrial engineering. All applicants must be in good standing with their colleges. Financial need is considered for most scholarships.

Undergraduate and graduate scholarships range up to $4,000 annually. Scholarships are awarded for one year only, but applicants may apply for a re-award for each year they are enrolled in school.

Scholarship Eligibility

1. Applicants for these scholarships must be full-time undergraduate students in either a four-year college or a two-year technical program or enrolled in a graduate program.
2. All applicants must be graduates of public or private high schools.

Scholarship Criteria

1. Applicants must have a demonstrated or expressed interest in the coloring of plastics industry.
2. Applicants must be majoring in or taking courses that would be beneficial to a career in the coloring of plastics industry.
3. An applicant must be in good academic standing with his or her school.
4. Preference is given to student members of SPE and also to students who have a parent(s) as a member of the Color & Appearance Division of the SPE.
5. Financial need of an applicant will be considered for most scholarships.

Application Procedure

To be considered for a scholarship from the Color & Appearance Division Endowment Scholarship Program, applicants must complete an application available on our website and return it to the address specified on the application by June 1, 2019 All submitted applications must include:

1. A completed application form.
2. Three recommendation letters: two from a teacher or school official and one from an employer or non-relative.
3. A high school and/or college transcript for the last two years.
4. An essay by the student (500 words or less) telling why the applicant is applying for the scholarship, the applicant's qualifications, and the applicant's educational and career goals in the coloring of plastics industry.

Please feel free to contact Ann Smeltzer by email or by phone at 412-298-4373 with any questions.

All scholarships will be paid directly to the recipients' schools.
The Color & Appearance Division Endowment Scholarship Program will not award scholarships to applicants who are not qualified and reserves the right to not award a scholarship in a given year if it so chooses.

Connect With SPE CAD Via Social Media

Please connect with us at any of the following Social Media sites by simply clicking on the logos below.

Join SPECAD's Group On **LinkedIn** 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
https://www.linkedin.com/groups/152108

QUALITY RESISTS.

Green, red, yellow, brown or black – our high-performance **Colortherm®** pigments have been particularly developed for the coloring of plastics. All pigments are easily dispersed and rapidly reach their final tinting strength. Their excellent properties in terms of heat stability, migration resistance, light-fastness and weather stability make them suited for almost any type of plastic. Thus, LANXESS quality ensures long lasting color stability combined with the highest technical standards.

BAYFERROX® Color for Life. COLORTHERM® Color for Life.

QUALITY WORKS.

LANXESS Energizing Chemistry

Technical Article
Effects of Gamma Irradiation on Colorants in PET and Co-Polyester

Paul Glas and Mark Treitman, Milliken & Company

PLASTICS AND ADDITIVES

Introduction

Over the years, Milliken has received multiple inquiries to the stability of colorants when exposed to gamma sterilization. Although the effects of gamma irradiation on polymers is well documented very little information is available on the effects of this type of sterilization on colorants. This paper is intended to explore the causations and effects of gamma exposure on selected colorants.

Background

There are several methods commonly used for sterilization currently in industry. Steam and dry heat are used for goods that are not hydroscopic or susceptible to damage from increased temperatures, such as reusable medical devices. The use of steam is obviously not practical for foodstuffs and materials that are inside of packaging.

Sterilization by gasses is another method commonly employed. Ethylene oxide, Nitrogen oxide and ozone are commonly used. The materials to be sterilized cannot be in packaging that will prevent exposure to the gasses used. During sterilization, a sealed chamber is used and filled with the sterilizing gasses. Time must be given to dissipate the gasses from the product, making this a batch process as opposed to continuous process. An additional disadvantage of a gas sterilization process is residuals of the process remaining on the exposed material.

Effects of Gamma Irradiation on Colorants in PET and Co-Polyester

Gamma and electron beam sterilization are among the most practical means of sterilization. Both methods use ionizing radiation to break bonds in DNA to kill the organism or leave it unable to reproduce **(figure 1).** As these methods do not come in contact with the materials to be sterilized and no mass is transferred the methods leave no residual radiation on materials. Electron beam methods employ beta radiation and have advantages as the area to be sterilized can be targeted directly, although the method cannot penetrate materials as effectively as gamma sterilization.

Gamma sterilization uses the radioisotope Cobalt 60 which is submerged in deionized water to shield facility personnel from exposure during maintenance. During the sterilization process the water levels are lowered to allow radiation exposure the inside of concrete lined chamber. Materials are loaded onto a conveyer system and moved around the radiation source exposing each side equally **(figure 2)**.

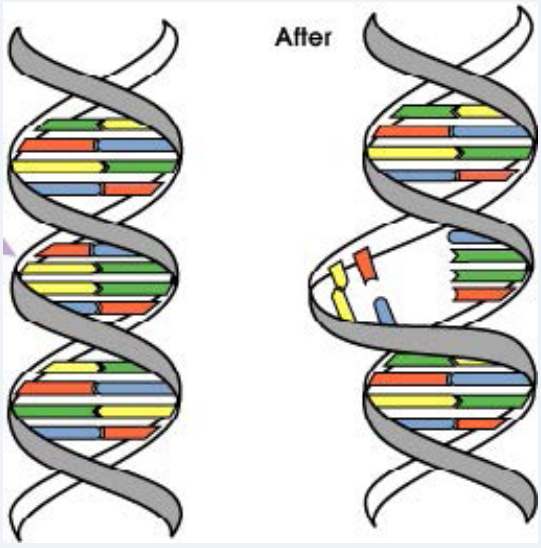

figure 1

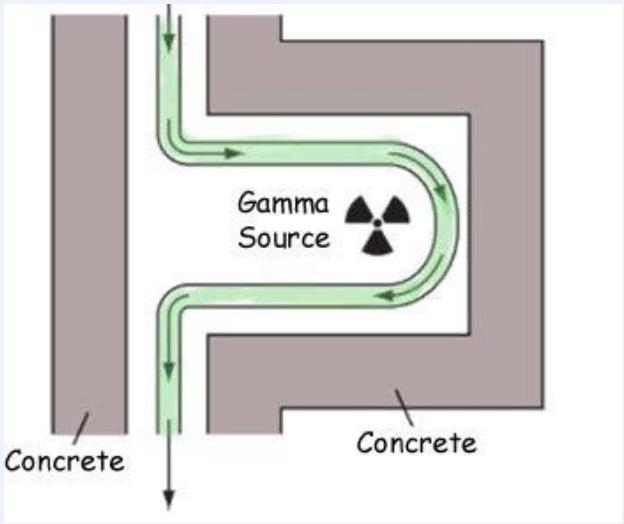

figure 2

Selection of Colorants and Polymers for Exposure

Two polymers were chosen for this study based on volume use in the current plastics industry, and currently market trends. In addition, the polymers chosen have demonstrated good resistance to gamma sterilization.

Polyethylene terephthalate (PET) commonly referred to as polyester was chosen for this study due to the broad industry acceptance of the material in food packaging applications such as beverage containers, prepared food clamshells and packaging film, bags and pouches. PET has good barrier properties and a strong recycling infrastructure make this a material well suited for this study.

A medical grade co-polyester was chosen as the second polymer for this study. Good chemical resistance, toughness and clarity have co-polyester making strong gains in medical parts and packaging. In addition, the concerns over BPA in polycarbonate have benefited the market share of Co-Polyester.

Colorants chosen for the study are organic dyes proven to good performance in PET and co-polyester polymers. As many different chemical types of dyes as feasible were included to help establish a corollary from the recorded results. Most of the dyes chosen have FDA compliance in PET currently.

A benzothiozole optical brightener (OB-1) was also included in the study as this material is commonly used in both polymers chosen.

In addition, a small selection of organic pigments with good performance in PET and co-polyester were included in the study to help establish trends in the study. These pigments, except for titanium dioxide, were limited to the Milliken color palette.

Finally control chips were also molded to the study. It is well documented that many polymers including polyesters shift in color after gamma exposure. Polymers can also revert in the direction of initial color exposure after resting as observed and documented by the resin manufacturer. These controls are needed to deduct polymer color shift from the observed results.

Structure of Experiment

Sample plaques were injection molded on a boy 22A injection molding machine. After color was observed to have good color distribution samples were taken of the second and third examples of each trial.
Organic dyes were prepared at a level of 0.025% were molded for measurement in transmission
Organic dyes for measurement in reflectance were prepared at a colorant level of .025%. Samples were molded with 0.25% titanium dioxide and 0.10% Ethylene bis-stearamide wax (EBS).

Organic pigments for measurement in transmission were prepared at a colorant level of 0.10% were molded. .015% mineral oil and .1% EBS wax was added to aid in distribution of the pigment and dispersion.

Organic pigments for measurement in reflectance were prepared at a colorant level of 0.10% with 0.25% titanium dioxide. .015% mineral oil and 0.1% EBS wax was added to aid in distribution of the pigment and dispersion.

The benzothiozole optical brightener was molded at 0.015% in both polymers as this level represents a typical use. Control plaques of the polymers, the polymers with additives, and polymers with titanium dioxide were also molded. Plaques were then placed in LDPE bags and attached to a tiered platform for gamma exposure. A tiered platform was used to eliminate the possibility of "shadowing" or having part of the sample receive more radiation energy inside of the exposure chamber (**figure 3**).

figure 3

Gamma exposure level

The tiered platform was placed inside of a standard cardboard box and delivered to the sterilization facility. Gamma exposure was specified to be set at a minimum expose of 25 kGy (kilograys) and a maximum exposure of 45 kGy as recommended by the sterilization facility. This dosage level represents a typical single dose exposure used in the sterilization of medical devices. Actual dose levels as measured were a minimum of 27.6 kGy and a maximum of 34.5 kGy as measured and documented by the exposure facility.

Procedure for chip measurement

After exposure, the samples were measured on a Datacolor 550 spectrophotometer for both transmission and reflectance. All samples were measured using 1976 CIE L*a*b* D6500 illuminant 10 degree observer spectral included. Samples were measured within 24 hours of exposure and again at an interval greater than 14 days to observe any changes that may have occurred after resting.

Results of Exposure Controls

PET

Sample chips molded in PET for transmission exhibited the following shift when measured within 24 hours of exposure to Gamma radiation.

Delta E 6.31
Delta L -2.48
Delta a 0.50
Delta b 5.79

As we see the polymer shifted darker, redder and yellower. After resting for a minimum of 14 days the polymer reverted toward its unexposed color substantially.

Delta E 1.92
Delta L -0.79
Delta a 0.28
Delta b 1.73

Similarly, sample chips molded in PET with 0.25% TiO2 exhibited the following shift when measured for reflectance within 24 hours of exposure to Gamma radiation.

Delta E 3.73
Delta L -2.97
Delta a 1.66
Delta b 1.53

Again, after resting for a minimum of 14 days the polymer in reflectance reverted toward its unexposed color substantially.

Delta E 0.75
Delta L -0.50
Delta a 0.55
Delta b 0.03

Control chips molded with 0.25% TiO_2 exhibited little to no change outside of the color shift of the PET polymer.

Co-Polyester

Sample chips molded in Co-Polyester for transmission exhibited the following shift when measured within 24 hours of exposure to Gamma radiation.

Delta E 2.92
Delta L -1.10
Delta a 0.63
Delta b 2.63

As we see the polymer shifted darker, redder and yellower.
After resting for a minimum of 14 days the polymer reverted back toward its unexposed color entirely.

Delta E 0.05
Delta L 0.03
Delta a -0.01
Delta b -0.04

Similarly, sample chips molded in Co-Polyester with 0.25% TiO2 exhibited the following shift when measured for reflectance within 24 hours of exposure to Gamma radiation.

Delta E 3.03
Delta L -2.75
Delta a 1.23
Delta b -0.33

Again, after resting for a minimum of 14 days the polymer in reflectance reverted back toward its unexposed color substantially.

Delta E 0.55
Delta L 0.48
Delta a -0.17
Delta b -0.20

Colorants

A total of sixteen dyes and four pigments of various chemistries were tested in the study. Colorants that performed poorly as follows;

Figure 4.

PET in Transmission (poor performance)

Delta E > 5.0)

	Delta *L	Delta *a	Delta*b	Delta *E
24 hours	-2.48	0.50	5.79	6.31
14 days	-0.79	0.28	1.73	1.92
ue 60 24 hours	-26.43	25.97	43.97	57.50
ue 60 14 days	-16.76	16.32	21.87	32.03
Flo. Orange 24 hours	-14.01	-16.83	-0.14	21.90
Flo. Orange 14 days	-5.63	-7.92	6.29	11.57
let 13 24 hours	-3.42	-35.70	38.41	52.56
let 13 14 days	-3.49	-25.17	27.55	37.48
llow 241 24 hours	-8.72	11.04	-9.47	16.96
llow 241 14 days	-4.46	6.62	-6.72	10.44
llow 147 24 hours	-24.96	2.47	-32.41	40.98
llow 147 14 days	-14.30	7.15	-16.13	23.07

Figure 6.

Co-Polyester in Transmission (poor performance)

Delta E > 5.0)

	Delta *L	Delta *a	Delta*b	Delta *E
Co-Polyester Natural 24 hours	-1.10	0.63	2.63	2.92
Co-Polyester Natural 14 days	0.03	-0.01	-0.04	0.05
Disperse Blue 60 24 hours	-17.05	14.93	32.71	39.79
Disperse Blue 60 14 days	-4.20	7.32	0.26	8.43
Proprietary Flo. Orange 24 hours	-11.60	-11.18	-9.78	18.84
Proprietary Flo. Orange 14 days	0.36	-2.35	2.02	3.12
Solvent Violet 13 24 hours	1.32	34.43	39.32	52.28
Solvent Violet 13 14 days	-0.92	-21.34	25.11	32.97
Disperse Yellow 241 24 hours	-4.63	7.62	-8.07	12.02
Disperse Yellow 241 14 days	-1.22	1.21	6.12	6.36
Pigment Yellow 147 24 hours	-13.04	-1.10	-15.90	20.59
Pigment Yellow 147 14 days	-1.28	2.55	-1.05	3.04

Figure 5.

PET in Reflectance (poor performance)

Delta E > 5.0)

	Delta *L	Delta *a	Delta*b	Delta *E
24 hours	-2.97	1.66	1.53	3.73
14 days	-0.5	0.55	-0.03	0.75
ue 60 24 hours	-4.95	6.84	9.78	12.92
ue 60 14 days	-2.58	4.26	4.31	6.59
Flo. Orange 24 hours	-6.23	-14.89	-9.38	18.67
Flo. Orange 14 days	-2.96	-7.48	-3.82	8.90
let 13 24 hours	0.10	-4.45	7.64	8.84
let 13 14 days	0.12	-3.55	6.11	7.06
llow 241 24 hours	-6.23	3.36	-11.92	13.86
llow 241 14 days	-3.10	2.99	-7.05	8.26
llow 147 24 hours	-12.41	-3.53	-20.61	24.31

Figure 7.

Co-Polyester in Reflectance (poor performance)

Delta E > 5.0)

	Delta *L	Delta *a	Delta*b	Delta *E
Co-Polyester Natural 24 hours	-2.75	1.23	-0.33	3.03
Co-Polyester Natural 14 days	0.48	-0.17	-0.20	0.55
Disperse Blue 60 24 hours	-3.05	2.30	8.84	9.62
Disperse Blue 60 14 days	-1.94	2.08	4.72	5.51
Proprietary Flo. Orange 24 hours	-5.71	-13.88	-10.79	18.48
Proprietary Flo. Orange 14 days	-2.29	-4.99	-4.35	7.00
Solvent Violet 13 24 hours	0.61	-5.96	9.66	11.36
Solvent Violet 13 14 days	0.34	-5.50	8.97	10.53
Disperse Yellow 241 24 hours	-5.96	4.12	-11.90	13.93
Disperse Yellow 241 14 days	-2.32	2.35	-5.82	6.69
Pigment Yellow 147 24 hours	-9.89	-4.83	-16.86	20.13
Pigment Yellow 147 14 days	-2.88	4.25	-4.61	6.90

Next, let us look at the colorants that performed acceptably;

Figure 8.

Co-Polyester in Transmission (acceptable performance)
(Delta E <5.0)

	Delta *L	Delta *a	Delta*b	Delta *E
Co-Polyester Natural 24 hours	-1.10	0.63	2.63	2.92
Co-Polyester Natural 14 days	0.03	-0.01	-0.04	0.05
Solvent Blue 104 24 hours	-1.70	-10.14	14.41	17.70
Solvent Blue 104 14 days	-0.59	-2.28	3.95	4.60
Disperse Orange 47 24 hours	-0.10	-1.33	-0.05	1.33
Disperse Orange 47 14 days	0.43	-0.75	0.83	1.20
Solvent Orange 60 24 hours	-0.78	-0.49	-3.34	3.47
Solvent Orange 60 14 days	0.16	-0.51	-2.04	2.11
Solvent Red 135 24 hours	3.03	-8.82	-1.20	9.40
Solvent Red 135 14 days	3.29	-5.85	-3.12	7.40
Disperse Yellow 201 24 hours	-0.92	1.77	0.08	2.00
Disperse Yellow 201 14 days	-0.10	0.06	-0.08	0.14
Solvent Yellow 93 24 hours	-0.59	0.95	-0.68	1.31
Solvent Yellow 93 14 days	0.08	0.34	-0.89	0.95
Solvent Yellow 114 24 hours	-1.03	1.46	0.26	1.81
Solvent Yellow 114 14 days	-0.15	0.31	0.35	0.49
Florescent Brightener 393 24 hours	-0.92	0.42	1.91	2.16
Florescent Brightener 393 14 days	-0.03	-0.21	0.06	0.23

Figure 9.

PET in Transmission (acceptable performance)
Delta E <(5.0)

	Delta *L	Delta *a	Delta*b	Delta *E
PET Natural 24 hours	-2.48	0.50	5.79	6.31
PET Natural 14 days	-0.79	0.28	1.73	1.92
Solvent Blue 104 24 hours	-3.24	-7.42	11.63	14.17
Solvent Blue 104 14 days	-1.49	-3.77	5.77	7.05
Disperse Orange 47 24 hours	-2.75	-4.86	-4.53	7.19
Disperse Orange 47 14 days	-0.67	-1.85	-1.03	2.22
Solvent Orange 60 24 hours	-3.02	-0.45	-4.83	5.71
Solvent Orange 60 14 days	-1.09	0.05	-2.37	2.61
Solvent Red 135 24 hours	-0.88	-5.59	3.39	6.60
Solvent Red 135 14 days	0.25	-3.30	0.59	3.37
Disperse Yellow 201 24 hours	-2.08	4.05	-0.90	5.00
Disperse Yellow 201 14 days	-1.10	1.78	-0.25	2.11
Solvent Yellow 93 24 hours	-2.71	3.02	-1.96	4.50
Solvent Yellow 93 14 days	-0.80	1.08	-1.18	1.79
Solvent Yellow 114 24 hours	-3.72	3.60	-1.20	5.32
Solvent Yellow 114 14 days	-1.42	2.03	0.49	2.52
Florescent Brightener 393 24 hours	-2.66	0.76	5.47	6.13
Florescent Brightener 393 14 days	-0.83	0.32	1.96	2.15

Figure 10.

PET in Reflectance (acceptable performance)
Delta E <(5.0)

	Delta *L	Delta *a	Delta*b	Delta *E
PET Natural 24 hours	-2.97	1.66	1.53	3.73
PET Natural 14 days	-0.5	0.55	-0.03	0.75
Solvent Blue 104 24 hours	-0.39	-1.16	3.43	3.64
Solvent Blue 104 14 days	-0.06	-0.50	1.38	1.47
Disperse Orange 47 24 hours	-1.51	-5.95	-4.00	7.32
Disperse Orange 47 14 days	0.00	-1.97	-1.35	2.38
Solvent Orange 60 24 hours	-2.25	-3.56	-4.49	6.15
Solvent Orange 60 14 days	-0.55	-0.98	-1.55	1.91
Solvent Red 135 24 hours	-0.55	-4.96	-1.70	5.27
Solvent Red 135 14 days	0.20	-2.15	-0.54	2.23
Disperse Yellow 201 24 hours	-2.29	1.57	-3.45	4.43
Disperse Yellow 201 14 days	-0.48	0.60	-0.88	1.18
Solvent Yellow 93 24 hours	-2.58	0.46	-4.62	5.31
Solvent Yellow 93 14 days	-0.30	-0.20	-1.09	1.15
Solvent Yellow 114 24 hours	-2.96	-0.99	-4.60	5.56
Solvent Yellow 114 14 days	-0.58	-0.32	-0.82	1.05

Figure 11.

Co-Polyester in Reflectance (acceptable performance)
(Delta E < 5.0)

	Delta *L	Delta *a	Delta*b	Delta *E
Co-Polyester Natural 24 hours	-2.75	1.23	-0.33	3.03
Co-Polyester Natural 14 days	0.48	-0.17	-0.20	0.55
Solvent Blue 104 24 hours	-0.28	-1.77	4.60	4.93
Solvent Blue 104 14 days	-0.24	-1.20	2.91	3.16
Disperse Orange 47 24 hours	-1.21	-4.00	-3.42	5.38
Disperse Orange 47 14 days	0.12	-0.37	-0.76	0.85
Solvent Orange 60 24 hours	-2.04	-3.07	-4.48	5.80
Solvent Orange 60 14 days	-0.08	0.19	-0.59	0.62
Solvent Red 135 24 hours	0.25	-6.80	-1.58	6.98
Solvent Red 135 14 days	1.34	-2.31	0.59	2.74
Disperse Yellow 201 24 hours	-2.78	1.96	-4.33	5.50
Disperse Yellow 201 14 days	-0.19	0.65	-0.11	0.69
Solvent Yellow 93 24 hours	-2.12	0.09	-4.21	4.71
Solvent Yellow 93 14 days	0.22	-0.16	-0.10	0.29
Solvent Yellow 114 24 hours	-2.52	-0.79	-4.17	4.93
Solvent Yellow 114 14 days	-0.15	0.75	-0.08	0.77

TECHNICAL ARTICLE CONTINUED

The following are colorants that exhibited marginal performance, defined by good performance in two or more polymer conditions and failure in the remaining conditions;

Figure 12.

PET in Transmission (Mariginal performance)

	Class	Delta *L	Delta *a	Delta*b	Delta *E
PET Natural 24 hours		-2.48	0.50	5.79	6.31
PET Natural 14 days		-0.79	0.28	1.73	1.92
Pigment Blue 15:1 24 hours		-21.98	31.53	6.18	38.93
Pigment Blue 15:1 14 days		-9.79	12.76	3.48	16.45
Solvent Green 3 24 hours		-3.17	5.46	6.28	8.91
Solvent Green 3 14 days		-1.98	4.07	2.84	5.35
Disperse Red 60 24 hours		-2.82	-8.80	15.67	18.19
Disperse Red 60 14 days		-1.35	-4.72	9.37	10.58
Solvent Red 195 24 hours		-1.00	-4.17	2.57	5.00
Solvent Red 195 14 days		0.25	-1.18	-1.61	2.01
Solvent Red H (proprietay) 24 hours		-5.55	-8.33	-8.88	13.38
Solvent Red H (proprietay) 14 days		-1.89	-3.54	-4.35	5.92
Pigment Red 177 24 hours		-5.91	-7.01	-9.48	13.19
Pigment Red 177 14 days		-2.87	-2.98	-4.47	6.09

Figure 13.

PET in Reflectance (Mariginal performance)

	Delta *L	Delta *a	Delta*b	Delta *E
PET Natural 24 hours	-2.97	1.66	1.53	3.73
PET Natural 14 days	-0.5	0.55	-0.03	0.75
Pigment Blue 15:1 24 hours	-3.08	4.14	4.67	6.69
Pigment Blue 15:1 14 days	-1.13	0.75	2.70	3.02
Solvent Green 3 24 hours	-0.32	1.67	0.48	1.76
Solvent Green 3 14 days	-0.16	1.13	0.23	1.16
Disperse Red 60 24 hours	-1.35	-5.74	-1.05	5.99
Disperse Red 60 14 days	-0.47	-2.46	-0.47	2.54
Solvent Red 195 24 hours	11.46	-29.41	10.92	34.54
Solvent Red 195 14 days	0.38	-1.25	-0.92	1.60
Solvent Red H (proprietay) 24 hours	-1.14	-5.73	-3.25	6.68
Solvent Red H (proprietay) 14 days	-0.05	-2.27	-1.37	2.65
Pigment Red 177 24 hours	-1.51	-4.53	-2.67	5.48
Pigment Red 177 14 days	-0.48	-1.24	-0.93	1.62

Figure 14.

Co-Polyester in Transmission (marginal performance)

	Delta *L	Delta *a	Delta*b	Delta *E
Co-Polyester Natural 24 hours	-1.10	0.63	2.63	2.92
Co-Polyester Natural 14 days	0.03	-0.01	-0.04	0.05
Pigment Blue 15:1 24 hours	-22.88	31.23	5.28	39.07
Pigment Blue 15:1 14 days	-1.42	-0.80	2.47	2.96
Solvent Green 3 24 hours	-1.96	8.60	10.84	13.98
Solvent Green 3 14 days	-2.37	7.07	2.79	7.96
Disperse Red 60 24 hours	-0.39	-9.11	15.65	18.11
Disperse Red 60 14 days	0.57	3.54	8.71	9.42
Solvent Red 195 24 hours	1.51	-1.34	-6.04	6.37
Solvent Red 195 14 days	1.96	1.24	-9.23	9.51
Solvent Red H (proprietay) 24 hours	-5.08	-10.00	-13.58	17.62
Solvent Red H (proprietay) 14 days	0.43	-2.51	-4.61	5.27
Pigment Red 177 24 hours	-2.14	-4.87	-2.56	5.91
Pigment Red 177 14 days	1.87	1.22	3.41	4.08

Figure 15.

Co-Polyester in Reflectance (marginal performance)

	Delta *L	Delta *a	Delta*b	Delta *E
Co-Polyester Natural 24 hours	-2.75	1.23	-0.33	3.03
Co-Polyester Natural 14 days	0.48	-0.17	-0.20	0.55
Pigment Blue 15:1 24 hours	-1.73	1.41	4.88	5.36
Pigment Blue 15:1 14 days	-0.65	-0.39	2.57	2.68
Solvent Green 3 24 hours	-0.30	2.68	1.18	2.95
Solvent Green 3 14 days	-0.41	2.13	0.89	2.35
Disperse Red 60 24 hours	-1.28	-7.24	-0.69	7.39
Disperse Red 60 14 days	-0.05	-1.87	1.40	2.34
Solvent Red 195 24 hours	0.08	-3.88	-2.26	4.49
Solvent Red 195 14 days	0.85	-0.13	-0.80	1.17
Solvent Red H (proprietay) 24 hours	-1.35	-8.37	-4.48	9.59
Solvent Red H (proprietay) 14 days	-0.28	-3.69	-2.22	4.31
Pigment Red 177 24 hours	N/A	N/A	N/A	N/A
Pigment Red 177 14 days	N/A	N/A	N/A	N/A

Observations

Titanium Dioxide and channel process carbon black were not affected by Gamma exposure.

Color shifts cannot be predicted based only on the shift of the resin alone as the actual observed color shifts could be on any side of the color axis.

Methine based dyes were the most stable of all Organic (excluding carbon black) colorants tested.

Anthraquinone based colorants seem to be the most susceptible to color shift, both in pigments and in dyes, although there are exceptions such as Solvent Blue 104 and Solvent green 3.

Clear trends in color shift were not apparent, although all colorants improved after the 14-day resting period.

Causation of observed color variation

Radiation interacts with polymers and colorants in two ways: chain scission, which results in reduced tensile strength and elongation in the polymer and is the destructive mechanism that is beneficial for damaging DNA as we saw earlier and crosslinking, which increases tensile strength but reduces elongation in the polymer.

Both reactions occur simultaneously, but one is usually dominant, depending upon the specific polymer and additives involved. Both reactions result in the formation of free radicals, or atoms with an unpaired electron. These free radicals will bond with the molecules on the colorant or polymer changing the structure of the colorant/polymer Matrix and therefore the way the colorant/polymer reflects light.

This change in light reflectance is perceived as a color shift.

As the colored polymer is removed from the source of radiation the materials begin to return to their original unexposed state, although in some cases the bonds formed during radiation exposure remain permanent, as does the shift in color.

Conclusions

Ascetically pleasing colors are possible to make in Gamma irradiated PET and Co-Polyester, although the colors will shift from their original state.

The scope of the paper is on simple tints and Masstones tested at levels consistent with current market trends and established testing methods. Complex, multiple colorant formulations would be expected to produce additional unforeseen reactions and must be tested individually.

Accurate predictions of colorant shifts in polymers exposed to gamma sterilization are nearly impossible to predict as shown in the readings of samples. A reasonable palette of colorants is possible as demonstrated in Figure 8-11, but careful testing is needed before guaranteeing color stability to a customer.

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Scott Aumann, 912-210-0175
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scott.aumann@xxxemdgroup.com,

Chuck DePew, 765-914-3363
Holland Colours Americas, Inc.
cdepew@xxxhollandcolours.com

Jim Figaniak, 215 736-1126
Infinity LTL
jim.figaniak@xxxltlcolor.com

Scott Heitzman, 513-681-5950
Sun Chemical Corporation
scott.heitzman@xxxsunchemical.com

Nathan Karszes, 770-527-2409
Ferro
nathan.karszes@xxxferro.com

George Iannuzzi 914-261-8189
Sandream
giannuzzi@sandreamimpact.com

Betty Puckerin, 812-466-9828
Ampacet Corporation
Betty.puckerin@xxxampacet.com

Mark Ryan, 513-874-0714
Shepherd Color
mryan@xxxshepherdcolor.com

Ann Smeltzer, 412-298-4373
Clariant Plastics & Coatings
ann.smeltzer@xxxclariant.com

DIRECTORS until 2020

Matt Billiter, 412-260-0146
LANXESS Corporation
matthew.billiter@xxxlanxess.com

Breeze Briggs, 248-304-5303
BASF Colors & Effects LLC
breeze.briggs@xxxbasf.com

Jeff Drusda, 302 683 8025
Chemours
jeffrey.drusda@chemours.com

Steve Esker, 614-679-4677
Paramount Colors, Inc.
steveesker@xxxhotmail.com

Daniel Hunter, 815-557-3098
Badger Color Concentrates, Inc.
dhunter@xxxbadgercolor.com

Dan Martelli 609-879-1512
Heubach Color
danmartelli@heubachcolor.com

Todd McHenry, 412-809-4732
LANXESS
todd.mchenry@xxxlanxess.com

Mercedes Landazuri, 219-764-3301
Apex Colors, Inc.
mlandazuri@apexcolors.com

Brenda (Mullins) Outlaw, 313-920-7113
BASF Colors & Effects
brenda.outlaw@xxxbasf.com

DIRECTORS until 2021

Earl Balthazar, 817-719-0224
DataColor
ebalthazar@xxxdatacolor.com

Sharon Ehr, 616-494-7577
Uniform Color
sehr@xxxuniformcolor.com

Ed Ford, 346-302-4610
Zeppelin Systems USA
ed.ford@xxxzeppelin-usa.com

Jack Ladson, 267-981-7112
Color Science Consultancy
jack@xxxColorScienceConsultancy.com

Alex Prosapio, 845-641-0596
Sudarshan Pigments
aprosapio@xxxsudarshan.com

Elizabeth Serdar 513-532-5559
OMYA Inc.
elizabeth.serdar@omya.com

Todd Waddle 216-695-7188
M. Holland
twaddle@mholland.com

Kimberly Williamson 706-892-8102
Techmer PM LLC
kwilliamson@techmerpm.com

Michael Willis, 513-681-5950
Sun Chemical
michael.willis@xxxsunchemical.com