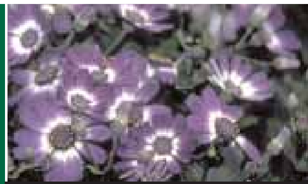

SPRING ISSUE 2009

Color and Appearance Division

CAD NEWS

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

Chairman's Message

Spring marks the time when our thoughts turn to fresh starts, change and growth. SPE CAD has "spring fever" as we introduce some exciting format changes for communication. This issue of CAD NEWS represents our first electronically distributed newsletter. Besides saving a few trees and reducing our carbon footprint, the new format allows us to publish a much more interactive newsletter with links to sponsor's websites and to event information.

Another first will take place in May, when the SPRING CAD Board of Directors meeting will be held using a web-based platform. This format will reduce travel expenses for the board members while allowing full participation. Growth continues in our group on the professional networking website LinkedIn.com. The "SPE Color & Appearance Division" LinkedIn group was started in September 2008 and continues to add members every week. We are also using this format as an additional communication tool for publicizing SPE CAD events and activities.

Transition occurs with the close ANTEC™ 2009 in June. It marks the transition of our newly elected board members into active service. ANTEC™ also marks the end of my term as SPE CAD Chairperson and the induction of Howard Kennedy as the next CAD Chairperson. Please join me in welcoming Howard. Howard has already made his mark on the board by serving on many committees and by leading our Strategic Planning committee. We look forward to Howard's visionary thinking and his special brand of Canadian humor as he takes over in June.

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Speaking of June, this year's ANTEC™ is special because it is being held concurrently with NPE in Chicago. It's not often we get a "two for one" special, so this year is a great opportunity to attend two conferences in the same location. I recall the first SPE ANTEC™ conference I ever attended. It was 1988 in Atlanta and the theme was "Plastics Are Shaping Tomorrow Today." *(That's me in 1988 with Rhett Butler at the ANTEC™ Welcome Reception.)* Needless to say, that ANTEC™ left quite an impression on me and started my interest in SPE participation. I never dreamed of eventually being on the CAD Board and serving the membership as Chairperson one day. It has been a privilege and an honor to serve in this capacity, and I am grateful for the opportunity to give back to an organization that has been the foundation of my professional network. I hope to see you at ANTEC™ and at CAD RETEC® 2009 *(October 18-20, Savannah)*. Please say "Hi" if you see me there!

Have a Colorful Day,

Tracy Phillips

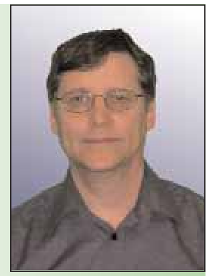
CAD Chairperson

Invitation to Attend Our CAD Board Meetings

The Color and Appearance Division regularly holds Technical Program Committee (TPC) and Board of Director (BOD) meetings at the ANTEC™ and the RETEC®. In addition, a Summer BOD and TPC meeting are typically held about 6 weeks prior to the RETEC®, and a Winter BOD and TPC meeting are held in early January. The Summer meeting is scheduled in various locations; the Winter meeting is typically held at the site of the RETEC® that is a year and a half away.

Any SPE/CAD members who wish to attend are welcome at these meetings. Contact the Division Chairman *(see the back cover)* for information on the location and times of any of these meetings.

Editor's Note



Welcome to the CAD's first electronic newsletter. The CAD Board has planned this transition for some time now, I hope you like the format. Please contact me at jprzybylski@terra.edu, or any board member, with comments or suggestions. The summer newsletter, the one that arrives before RETEC®, will continue to be a traditional printed copy.

On a sad note, an important contributor to color science for over 60 years, Fred Simon, has recently passed away. Fred had been involved with the CAD for many years and had presented several papers. To honor his contribution, I have reprinted a paper Fred presented at the 1990 RETEC®. It is entitled *"A Guide to Teaching Color to People"*, which was a subject that occupied large part of his professional life. Also, Fred's obituary is included.

This year ANTEC™ and NPE will be held together in Chicago for the first time. It is a great opportunity to attend both events in one trip. See the ad on page 15 for details.

Hope to see you in Chicago. Jamie Przybylski

Jamie Przybylski
Editor

FUTURE ANTEC™ MEETINGS

2009 - June 22-24 *(McCormick Place)* Chicago, Illinois

2010 - May 16-20 Orlando, Florida

2011 - May 1-5 Boston, Massachusetts

FUTURE RETEC® MEETINGS

2009 RETEC® Savannah, GA
Venue: Hyatt Regency Savannah
Dates: October 18th - 20th - 2009
Chair: Scott Aumann

2010 RETEC® Nashville, TN
Venue: Renaissance Nashville Hotel
Dates: Sept 12-14, 2010
Chair: Brian West

2011 RETEC® Chicago, IL
Chair: Sharon Ehr

Board of Directors Meeting Minutes

Society of Plastics Engineers - Color and Appearance Division Board of Directors and Committee Meetings from September 24, 2008

September 24, 2008

OPENING/WELCOME (TRACY PHILLIPS)

Reading of Antitrust Policy. New Board Members were assigned mentors: Kenichi Kawasaki (*Howard Kennedy*), Ed Ford (*Roger Reinicker*), Mark Tyler (*Scott Heitzman*), Betty Puckerin (*Tracy Phillips*). Welcome to guest Tricia McKnight from iSPE.

SECRETARY'S REPORT (SCOTT HEITZMAN)

- BOD contact list passed around for updates and corrections.
- Meeting attendance roster circulated.
- Approval of the minutes from the Winter 2008 BOD meeting was requested. There was a motion by A. Reid to accept. S. Goldstein seconded. Motion to approve passed.
- Request made for any detailed reports to be electronically submitted to board secretary for inclusion in these minutes.

TREASURER'S REPORT (BRUCE MULHOLLAND)

- Audit Committee reviewed the Annual Report during RETEC® and approved 9-24-08.
- Only income from time of the last report *(Summer Meeting)* was interest on accounts.
- Only expenses from time of the last report *(Summer Meeting)* was cost for Summer Meeting.
- A Motion was made by Tracy Phillips to approve the report, seconded by Bruce Mulholland and approved.

COUNCILOR'S REPORT (SANDRA DAVIS)

- iSPE reports membership continues to decline. A strategy plan and budget are being compiled. The target demographic is 25-45 age groups. The strategy will focus on new membership and retention in this area. Plan will include adaptability to utilize the changing type of volunteer. Optimization of the Organization and Branding will continue *(for example, utilizing social networking websites to promote SPE).*
- The next council meeting is scheduled for Oct 17-18 in Southbury, CT. Sandra Davis will represent CAD.

ANTEC™ TECHNICAL PROGRAM COMMITTEE (BRUCE MULHOLLAND)

ANTEC™ 2009 (Chicago, IL) - Roger Reinicker / Tracy Phillips

- Dates June 22, 23, 24 coincide with NPE
- CAD Board meeting tentatively on Monday, 22nd
- Sessions targeted for am and pm Tuesday 23rd.Nine to eleven papers, speakers
- 6 presenters have abstracts submitted with 3 additional commitments. Papers due November 14th.
- Keynote on color basics is always well attended. Invitation board members to volunteer to give the keynote.
- We will not pursue a joint session with the PMAD.
- Headquarters Hotel and meeting space for board meeting needs to be identified ASAP. Tricia McKnight will report on available space in currently contracted hotels. Sharon Ehr will check with the Holiday Inn to see if they will offer some meeting space.
- Matrix meeting is scheduled for Dec 15, 2008.

ANTEC™ 2010 (Orlando, FL) Jim O'Dwyer, Sharyl Reid *(vice Chair* No action to report.
ANTEC™ 2011 (Boston, MA) No action to report.

RETEC® TECHNICAL PROGRAM COMMITTEE (SANDRA DAVIS)

RETEC® 2008 (Hyatt Dearborn, MI) w/DCC Sept 21-23, 2008 - Bruce Mulholland,

- RETEC® 2008 was a success with about 400 in attendance, Positive comments on Registration, Reception, Networking, Meeting location, NTF, Key note speaker….
- No strong presence form OEM's and brand owners. Action to revise our marketing and fee structure to attract OEM's and brand owners.
- Suggestions for 2009: Close Tabletops during lunch. Print awards in preprint

RETEC® 2009 (Savannah, GA,) Oct. 18-20, 2009 – Scott Aumann, Earl Balthazar *(vice-chair)*

- Technical Program Chairs will be Ann Smeltzer and Earl Balthazar. 9 papers to date.
- No contract with overflow hotel to date. Plenty of options. Contract and room night review in progress.
- General buzz is that Savanna will be a destination hotel and a large turnout is expected.
- Need final brochure at NPE for distribution
- Suggested closing Tabletops for lunch
- Call for Papers-issue after November 15.

RETEC® 2010 Nashville, TN, Sept. 13-15, 2010 – Brian West / Austin Reid *(vice-chair)*

- Monday, Tuesday, Wednesday format will be used.
- Renaissance-Crown Plaza hotel downtown will be used.
- Theme "A Symphony of Color, 2nd Movement"
- Contract and room nights will be based on Dearborn, MI numbers. (*target 400 attendees)*

RETEC® 2011 (Chicago, IL) – Sharon Ehr, Steve Esker *(vice-chair)*

- No hotel selected to date. Will target outside of downtown. *(Schaumburg area-8 miles from O'Hare)*
- We will be working with the Chicago Section.

COMMITTEES

Operating guidelines will be updated by the executive board and submitted for approval at the Winter 09 meeting.

STRATEGIC PLANNING COMMITTEE (HOWARD KENNEDY)

- Committee met on improving attendance at ANTEC™ and RETEC®. On-line training, targeting the people left behind, targeting the brand owners and OEM's, cyber meetings, virtual table tops were a few concepts.

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- Estimated cost for a virtual RETEC® would be $50,000 USD. Tracy Phillips will obtain an Omnipress proposal. Jamie Przybylski will bring a newly hired (Terra) resource to the next meeting or as requested.
- Ed Tucker suggested a offering a Technician Certification online or at RETEC® to attract the young professional who cannot leave the office.

WEB-SITE AND NEWSLETTER COMMITTEE (J. PRZYBYLSKI A. REID, T PHILLIPS, JOE CAMERON)

- Next issue will be out before the end of the year. This will meet our target of 3 per our commitment to sponsors.
- Roger Reinicker suggested adding a trivia/reference page to website compiling tradenames of colorants.
- Tricia McKnight to provide a membership market list to explore other publicity avenues and to provide information on advertising events on new 4spe.org website

EDUCATION COMMITTEE (BOB CHARVAT, JAMIE PRZYBYLSKI)

- Plastics museum is closing. SPI now manages it-close out committee.
- Job clearing house has been slow.
- Students are finding jobs however its harder to find students.

ENDOWMENT COMMITTEE (JOHNNY SUTHERS)

- Eight applicants to date. Quality of applicants has improved. 5 Scholarships will be awarded: 3 to Grad students and 2 to Ferris State students.

Student	University / College	Named Scholarship
Ji-sook Chang	College for Creative Studies	
Jason Merkle	Ferris State University	Bob Charvat
Sarah Strauss	U. Massachusetts, Lowell	Jack Graff
Carl Sluis	College for Creative Studies	
Allissa Witucki	Ferris State University	Gary Beebe

- Johnny Suthers to arrange distribution of scholarship information for promotion at iSPE student reception.
- Revision will be made to application *(Electronic Forms)* to assist in contacting students and transferring funds directly to the student's registrar office.

AWARDS COMMITTEE (STEVE GOLDSTEIN)

- Recommendations to move to group photos for awards and sponsor as they can be better used in newsletter and save some time at ceremony.
- Recommendation to script awards ceremony to explain the purpose/reason for the award.
- Dave Johnson and Sandy Davis should have received Honored Service awards at RETEC® . Need to include in ceremony at 2009 RETEC® .

PUBLIC INTEREST (JACK LADSON)

- 130 filled in survey forms were received at RETEC®. Committee will review the data and report.
- A good observation was made by the Terra Students manning the booth; participants of the survey had a difficult time committing to a yes or no answer on questions relating to activity. We may want to consider a revision to the form to include an option: ok to be contacted.

COLOR ADVISORY GROUP (JACK LADSON)

Our cooperation with DCC in updating standards can be recorded as activity towards the iSPE Pinnacle award.

MEMBERSHIP COMMITTEE (ROGER REINICKER)

- Membership down 200 members.
- SPE CAD groups were created on facebook.com and linkedin.com in September 2008.

INTERNATIONAL COMMITTEE (BRIAN WEST)

- European ACE has a RETEC® scheduled for March 11-12, 2009
- Asked Cesar Morales to help with Spanish translations
- Jim Figaniak agreed to help with China.
- Brian West to focus on Portugal.
- Jack Ladson presented a presentation in Malaysia and Thailand- a Pinnacle reportable.

ARCHIVE DVD (TRACY PHILLIPS)

- 500 delivered 15 sold and 4 awarded as prizes. News brief will be sent to promote the Archive.
- There was a minor error found in the search function. Omnipress to replace DVDs at no charge. Purchases already distributed will receive an updated DVD.
- After month end price will be $200 USD for members and $300 USD for nonmembers.
- A motion was made by Tracy Phillips to provide a disc to Terri Belcher and Bob Charvat for their service. The motion was seconded by Sharon Ehr and unanimously approved.

OLD BUSINESS (ALL)

- Reviewed & updated existing action item list. *(Attachment #2)*
- Reviewed status of new logo shirts for BOD members and sale.
- Send shirt size and color preference to Sharon Ehr.

NEW BUSINESS (ALL)

- General discussion on using both a vertical and horizontal orientation of the logo as needed. Bruce Mulholland to forward upon new logo roll out by iSPE.
- General discussion surrounding CAD having their own release form. Decision to be made at January 09 meeting.
- Need to solicit candidates for reelection and election to the BOD and executive committee.
- Provide a news brief to solicit new candidates. Councilor position will be part of the general election.
- Elections: Take nominations for Secretary position at January 09 meeting.

NEXT MEETING (TRACY PHILLIPS)

- October/November-Executive Committee Only Conference Call to propose operating rule updates.
- Winter Board meeting- January 15-16, 2009

COLOR & APPEARANCE DIVISION BOARD OF DIRECTORS MEETING *9/24/2008* CONTINUED

OPEN ACTION ITEMS

From RETEC 2008 CAD BOD Meeting	Assigned to	Due	Status
News Brief for elections and selection of candidates.	H. Kennedy	9-Jan	
Schedule conference call with Executive committee to review and edit Operating Rules	T. Phillips	8-Dec	
News Brief for promotion of CD archive.	T. Phillips	9-Jan	
Provide new logos w/ updated orientation & iSPE change (from Tricia) to Sharon and Tracy. Trademark register two styles of the logo (horizontal/vertical)	B. Mulholland	9-Jan	
Provide data from surveys on candidates for papers.	J. Ladson	9-Nov	
Website: Update scholarship recipients, Awards information. Create shopping cart w/ Bruce M. Post Powerpoint presentation on Archive DVD. Post RETEC 2009 call for papers after Nov. 14.	T. Phillips	9-Jan	
Provided detailed list of CAD awards to Awards committee.	T. Phillips	9-Jan	
Revise scholarship form w/ more contact info-website	J. Suthers	9-Jan	
Website: Publish BOD member history	T. Phillips	9-Mar	
Schedule Omnipress proposal for recording meetings for website posting-at Winter Board Meeting	T. Phillips	9-Jan	
Schedule Terra Resource to give overview of how distance learning/internet posting can be done-Winter Board meeting	J. Pryzbylski	9-Jan	
Coloring Plastics Tutorial available on line—Plan for video recording the seminar	R. Charvat; J. Pryzbylski	9-Jan	
Review and present available mailing list for purchase.	T. McKnight	9-Jan	
Publish RETEC Wrap-Up newsletter by year end (hard copy). Include Scholarship application. Include Archive DVD advertisement. Include RETEC 2009 Call for Papers.	J. Przybylski	8-Dec	
Call for papers News Brief - RETEC 09	E. Balthazar	8-Dec	
Report on tradename information available for addition to web.	R. Reinicker	9-Jan	
Investigation of Hotel meeting space for ANTEC BOD meeting	S. Ehr	8-Dec	
Investigation of Hotel meeting space for ANTEC BOD meeting via ISPE contract	T. McKnight	8-Dec	
From Summer 2008 CAD BOD Meeting	**Assigned to**	**Due**	**Status**
Distribute info on scholarships at iSPE reception	J. Sutters	9-Jun	
SOP for BOD meeting via web or phone	T. Phillips	9-Jan	
Schedule Conf Call with Exec Committee to review.	T.Phillips	8-Dec	In progress
Add TPC.001 to CAD Toolbox	J.Cameron fwd to T. Phillips	9-Jan	
Resolve issues between Wiley, Write Now instructions for papers	Paper Review Committee	9-Jan	
From Winter 2008 CAD BOD Meeting	**Assigned to**	**Due**	**Status**
Amended Bylaws to all BOD members	E. Balthazar	9-Jan	
Committee member rosters to S. Heitzman	All Committee Chairs	9-Jan	
Distribute Wiley journal format template	R. Charvat	9-Jan	
From RETEC 2007 CAD BOD Meeting	**Assigned to**	**Due**	**Status**
CAD business card prototype	A. Smeltzer	9-Jan	
From ANTEC 2007 CAD BOD Meeting	**Assigned to**	**Due**	**Status**
Send the BOD members the web link to order embroidered golf shirts with the new SPECAD logo	S. Ehr	9-Jan	On hold for new logo

ACTION ITEMS-COMPLETED:

From Summer 2008 CAD BOD Meeting	Assigned to	Due	Status
strategy session conducted in on LRP	H. Kennedy	9-Jan	completed
Attend iSPE budget meetings	TP, AR, MB	8-Dec	completed
Update and distribute Committee Forms.	T.Phillips	8-Sep	completed

YOUR COMPANY, OUR DIVISION

The Color and Appearance Division *(CAD)* is committed to the publishing of at least three newsletters a year *(four, if there is sufficient material to justify the extra issue).* To that end, we would like you to think about the financial side of sponsorship of the newsletter. For the small donation of $300 per year, we offer a business card sized *(2 x 3.5 inches)* mention in our newsletter, which goes out to the nearly 1,500 members of the CAD as well as other SPE division members. These are people active in every aspect of plastic coloring and additive technology. Larger sized spots are available at a commensurate increase in rate.

If you are interested in helping to sponsor the SPE/CAD Newsletter please contact:

SHARYL REID, A. SCHULMAN
Phone: 864-968-2426 **Fax: 864-968-9515**
Email: Sharyl_Reid@us.aschulman.com.

Please visit the websites of the sponsors listed in this newsletter by clicking on web address included in their sponsorship space.

Thank you!

In Honor Of Frederick Tyler Simon

Frederick Tyler Simon passed away at his home on February 16, 2009, at the age of 91. Fred was born in Pittsburgh PA, and is survived by Irene, his wife of 62 years. He is also survived by his daughters Karla Simon of Annapolis MD and Frances Simon of Greenville SC, two grandsons, and his sister. Fred was educated at Carnegie Mellon University, Philadelphia College, Charleston University, and Marshall University. His career began at Union Carbide as a chemist before joining the faculty of Clemson University in 1968 as the Sirrine Professor of Textile Science. He later became Professor Emeritus of Textile Science.

Fred contributed to the field of color science both by his innovative solutions to problems of industrial color measurement, and by his training of numerous graduate students. Fred's industrial legacy includes the Simon-Goodwin color charts for color identification, the two-mode method for simplifying the measurement of fluorescent samples with a single monochromator spectrophotometer, the 555 method of shade grouping according to tolerances in three parameters (DL*a*b* or DL*C*H*), industrial color standards, fluorescent color matching, and many other projects. His later interests led him to graphic arts applications, also at Clemson University. Fred's human legacy includes individuals today working in academic and industrial settings in a variety of color-related tasks. He lived and taught in many foreign countries throughout his life and maintained conversational ability in several languages.

Fred could sometimes be prickly with students and colleagues, as many of us who worked with him can attest. There were rewards for working with him also, and he left a lasting mark on the industry. The last time I visited Fred and Irene was at their home in Clemson in December 2007. Fred was lamenting that squirrels had overrun his yard, and his pellet gun was broken. By happy coincidence, my then 10-year-old son had optimistically and stealthily packed two pellet guns into my car, and soon he and Fred were off in pursuit of the squirrels, looking like two Elmer Fudds. *(The squirrels were clearly not in any danger.)* He and Irene were long time communicants of Holy Trinity Episcopal Church in Clemson and have a special affinity for its mission church, St. Paul's in Pendleton.

During the last 10 years, his daily passion was woodworking, building numerous pieces of furniture and toys for his friends and family. Mr. Simon recently completed the construction of new red, entry doors for St. Paul's which were dedicated to Irene. He was active in the Pendleton District Woodworkers and the Greenville Woodworkers Guild. Many who knew him would agree that Mr. Simon was a hard worker, a good provider and motivated his loved ones to strive for great things in their lives.

The following technical article: A GUIDE TO TEACH COLOR FOR PEOPLE, is authored by Mr. Simon.

Guide to Teaching Color To People

INTRODUCTION

Color is something that everyone knows about. It is something that we see (provided that we are not blind) so it is not an abstraction or something that we feel, smell, or hear. The key to color is that we perceive it with our eyes and an understanding of it is gained through visual experience. The problem with teaching color is that it is a commonly shared sensation but the understanding of the "why" of color may not be well organized among those who have not studied more or less scientifically. It is this understanding that is necessary to those who must deal with how color is produced and how it behaves in the real world. Although color is very important to the artist, the thrust of this discussion will be in the field of applied color such as that which is of interest to the industrial colorist in plastics or in allied fields such as paint, printing, ink and textiles.

***FORMAL TEACHING POSSIBILITIES**

There are many ways that the formal science of color is taught to students at all educational levels. The top of the teaching scale is generally regarded as the university graduate school which leads to MS or PhD degrees with the emphasis on research done in color. Less involved color courses may be completely appropriate to practical applications of color even though they do not result in a terminal degree. Sufficed to say, every situation has its own requirements. The following list is indicative of several types of courses in the USA which are now offered or had been available in the last few years.

University level PhD color programs:

Rensselaer Polytech, Clemson, and Lehigh
All of these are now terminated

University level MS color programs:

Rochester Institute of Technology - current;
Rensselaer and Clemson - terminated

University level BS color programs:

Philadelphia College of Textiles and Science
Now terminated

University level color courses (one semester):

Rochester, Philadelphia, NC State,
Georgia, Cornell

**Editor's Note: This paper was written in 1990 so is not up to date. For instance Terra Community College is now a possibility for associate degrees and shorter certificates in color.*

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GUIDE TO TEACHING COLOR TO PEOPLE

By Frederick T. Simon, Frederick T. Simon, Inc. Clemson, SC

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In addition to the form instruction given at universities, much of the color science course instruction has been given as short courses with educational, technical organizations, and instrument manufacturers as the sponsor. These are supported by registration fees and are offered in several parts of the country. The courses last from a few days to a week and usually incur the added cost of travel and living expenses in the attendee. They are generally a series of lectures given by experts in the field and occasionally supplemented by hands-on laboratory experiments. A few examples are given to indicate what is available.
Educational institution sponsored:
Rochester, Philadelphia, NC State, Clemson
Technical organization sponsored:
American Association of Textile Chemists and Colorists, Society of Plastic Engineers
Instrument manufacturers:
Applied Color Systems, Byk-Gardner Laboratory, Hunterlab, Technidyne

ON-THE-JOB-TRAINING

The formal training which is afforded by university level or short courses is generally not as specifically useful to the new color technologist as might be desired. Unfortunately, with the exception of training courses in connection with certain instruments, short courses are broad in scope and may have a minimum of contact that is immediately meaningful. Alternatively, on-site training can be directed to the needs of the trainee and be taught by an experienced person who either knows the local situation or is directed to achieve limited goals. What has been missing is a consistent outline of the subjects needed to augment the rudimentary knowledge that a new technician brings with him from early training and common experience. He needs to learn to perform the tasks of applied color science common to industry as we know it today yet draw on his prior understanding. There are tools and concepts that are likely to be unfamiliar to the novice but he can easily be trained to make them a part of his repertoire provided that the explanation is rational and, if possible, related to common knowledge.

To me the problem of teaching color reduces to ideas that are common to most sciences:

Teach principals illustrated with simple examples
It is the purpose of this paper to give a guide which describes the principles needed for a general understanding of color science and to suggest a few illustrations that should make the comprehension more plausible. This guide is directed to the management and super vision of color operations which include color laboratories, quality control groups and engineering organization. Unfortunately, all too often training of new employees is not carefully considered and the attitude prevails of "let George do it" and "George" may not have the broad picture of what is needed.

It stands to reason that attendance at one of the courses described above is a good beginning but basic information must always be translated into specific applications when employees are required to perform responsible tasks. In other words, despite outside training, the color technician needs review and assistance to develop the confidence that comes from knowing the specific equipment and methods that apply to his job. This can only come from on-the-job training.

The following is a brief description of the principles that need to be covered without attempting to give the detail that is necessary to teach each subject fully. A simple example is given with each principle of how this can be illustrated to the person who is learning about color. No attempt is made to cover the more exotic or less frequently encountered aspects of color; these can come later.

Principle 1 - What is Color - Rule of 3

Color is an interaction of three things: light, the eye of the observer, and the reflection (or transmittance of the object). All of these elements must be present for color to exist and the principle can be expressed as an algebraic equation:

COLOR = LIGHT * EYE * REFLECTANCE OF OBJECT

It stands to reason that if any of these elements is missing or equal to zero, there is no color. This is illustrated when we close our eyes, or have no light, there is no color. To fulfill the "rule of 3," it is appropriate to introduce the idea that a total black is without color because its reflectance is zero. More of the reflectance (or transmittance) idea is developed later.

Principle 2 - Measuring Color - Spectro and Colorimeter

An instrument can measure a colored object and give a set of physical data which are uniquely characteristic of the

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object. If the instrument is a spectro, the data are the spectrophotometric curve of the objet which only describes the physical response of the object to various parts of the spectrum. This is only one-third of the color equation. A colorimeter on the other hand can calculate a numerical analogy to the color of an object, taking into consideration a specific light source and the response of a typical eye and the reflection of the object. When a spectro is connected to a computer, the same calculation that is done with a colorimeter can be carried out in the computer. Think of the colorimeter as a color TV set that give numbers which represent each color seen on the screen. The spectro analyzes colors similar to a rainbow.

Principle 3 - Spectrophotometric Curves - Fingerprints of Color

When a color is measured versus white with a spectro, a characteristic curve of the reflection (vertical axis) versus the wavelength of light (horizontal axis). This is only the analytical representation of the color but is unique for a given color. The "amount" or intensity of a color is related to the curve's vertical position. This a curve that is approximately a horizontal line and close to the tope will be that of a white and one nearly at the bottom will be a black; grays are represented by intermediate horizontal lines

Chromatic colors - other than white-gray-black - have curves that show most absorption of the complementary (opposite) parts of the visible spectrum. To illustrate this, divide the spectrum scale from 400 to 700 nm in six 50mn segments and name them according to the six parts of the spectrum, violet, blue, green, yellow, orange, red. Thus the lowest part of a spectral curve will be the most light absorbed by the object and will be color fingerprint of the measured object.

Spectral Region	Spectral Light	Complementary Color
450-500 nm	Blue	Orange
500-550 nm	Green	Red
550-600 nm	Yellow	Violet
600-650 nm	Orange	Blue
650-700 nm	Red	Green

Although this split of the spectrum is not perfectly accurate, the idea is close enough to demonstrate the principle.

Principle 4 - Concentration - How Colorants Behave

The effect of the amount of a colorant applied to a substrate is related to the spectral curve in a reciprocal fashion; that is, the more colorant present, the lower the reflectance, particularly at the wavelength of maximum absorption. Moreover, equal differences in the visible effect of concentration changes in a colorant is related to ratio of the amount, not the simple difference in concentration. A more accurate expression of this relationship is given by the Kubelka-Munk equation:

Concentration = (1.0 - reflection)2/(2 * reflection)

where reflection is expressed as a decimal fraction

This expression is used to calculate relative concentrations of two or more samples of colored materials where the type of colorant(s) is known and the amount is not known.

Principle 5 - Color Description - Words and Relative Terms

The language of color can be used to describe and communicate information among people. It follows that this language obeys the "rule of 3" to convey proper meaning. Several sets of words are used by different people but can be equivalent:

Lightness	Saturation	Hue
Light-dark	Bright-dull	Red-Yellow-Green-Blue
Value	Chroma	Hue (Munsell)
Light-dark	Strong-weak	Red-Yellow-Green-Blue

When describing differences between pairs, industrial practice may dictate one of the sets of terms used in an adjectival or relative sense. There are no fixed rules that say that one set is preferable to another but it is necessary to use three terms to be have complete communication.

Principle 6 - Colorimetry - Interpretation of Measurements

An instrumental measurement of a sample results in numerical data which is made meaningful by deriving some terms that parallel the way we see color. For example, a spectro only can measure a sample and give a spectral curve of reflectance versus wavelength. This is one of the three things that define color. Therefore the counterparts of the other two parameters, light and "the eye," must be added to provide a colorimetric description of the measured color. Values for the typical lights and "eyes" are given by the standardizing body for color, the CIE, as numerical table for various illuminants and color matching functions. The illuminant tables give selections for several light sources and the visual functions for a standard observer in terms of three

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responses. The "red" response is called x, the "green" response is called y; and the "blue" response is called z. After multiplying the reflectance data by illuminant and color matching functions, three values, X, Y, and Z are obtained which correlate in a rough way to the visual effect of that color. These calculations which are called tristimulus integration are performed in a computer attached to the spectro. Colorimeters on the other hand usually provide equivalent data through filters which are tailored to give X, Y, and X responses directly.

It must be clearly understood that the instrument can be a stand-in for the human observer only if the computation and measurement are exactly equivalent; otherwise, numerical data, although useful, cannot be a direct replacement for what you see.

Principle 7 - Color Description - Axes and Quantities

With color measurement, the results may not be easily interpreted unless they are expressed as numbers which relate to those color terms given previously. The CIE provides additional scales that are easier to understand than X, Y, Z and are mathematically derived from them. The most straightforward is a L*, lightness scale, which comes from Y through an equation based on the cube root of Y. There are also equations for two other axes, a* and b*, which plot perpendicular to L* axis. a* and b* intersect at the neutral or gray point. The a* axis extends from neutral towards pure red in the positive direction and towards pure green in the negative direction. The b* axis describes the yellow (plus)-blue directions from neutral. The absolute values of L*, a*, and b* give unique numerical values that locate any color in the space. However, it is generally more important to know color differences, "deltas", which quantify visual color differences. The L*, a*, b* color space is simply calculated from X, Y, Z and is in widespread use, but a more easily understood and practical derivation is C* and h rather than a* and b*. These are also specified by the CIE and are called psychometric scales since we think of color in terms of Hue (h) and Chroma (C) which plot colors in polar coordinates that distribute various Hues around the L* neutral axis and C*expresses the planar distance from the L* axis.

What is important to the color technician is to be able to interpret instrumental data obtained on individual samples or pairs of samples visually meaningful terms. This is a powerful tool which is at his disposal with colorimeters and spectros+computers.

Principle 8 - Matamerism - Color Differences May Not Be Constant

This term is used to describe the difference in appearance of a pair of samples when viewed under more one condition of illumination. This is the result of differences in the spectral curves of the two materials. Although there are other manifestations of matamerism such as the difference in color vision of observers, the most common instance that shows up matamerism is changes in illumination.

An index which gives a number for metamerism can be calculated by taking the difference between color differences computed for two illuminants for a pair of samples. Metameric indices can be calculated for any number of illuminant pairs.

Principle 9 - Color Mixing - Additive, Subtractive, and Partitive

Most colors that we see are not the result of a single color by itself but are achieved by mixtures of colors or colorants which provide diversity by combining two or more individuals in myriad proportions.

This is what gives the variety of colors that we enjoy. It is necessary to understand, however, that light and the color of objects behave differently. When lights of different colors are mixed together by superposing them, they add together. This is commonly observes in theater stage lighting. Plastics, paints, textiles, and coated paper owe their coloration to colorants (pigments or dyes) which selectively absorb - subtract - light. Partitive mixing in object color is a combination of subtractive and additive effects. The most common example of partitive color mixing is in rotogravure printing of paper. Subtractive mixing is the most common type and is the basis of this discussion.

Principle 10 - Matching Colors - Outside and Inside Colorants

No matter whether a color is matches by eye and visual estimation or with the aid of an instrument-spectro combination that is used to generate formulas, the basics remain the same: three bright colorants whose hues are far apart will match the greatest number of colors. A minimum of three colorants is needed to give flexibility in matching. Common examples of sets of bright colorants are derived from Yellow, Orange, red, violet, Blue, and Green. These are called "outside" colorants. On the other hand, experience has shown that if there is the opportunity to use colorants

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close to the color being matched. Examples of these are black, gray, olive, brown, and navy colorants. These are termed "inside" colorants which have the advantage of better color control and frequently lower cost. Since matches of plastics frequently require an opacifier, white pigment is added to the mix of all but the darkest colors.

Principle 11 - Controlling Metamerism - More Colorants

Many color matches in plastics are commonly made with white, black, and two chromatic pigments. If the standard is similar in composition to that which is being produced, it is possible to obtain a spectral match by identifying the colorants used in the standard and imitating them in the trial. Unfortunately, typical situations in the real world require matches to all types of materials which preclude spectral matches. Compromise is warranted between adjusting the spectral curve which usually means adding another chromatic pigment to the formula. In effect the number of degrees of freedom is increased to accommodate metamerism which can be either observed by looking at a trial and a standard under two or more illuminants; it is calculated in computer formulation programs.

Experience with interpreting spectral curves can provide a good insight on how to make changes in the colorants to reduce metamerism. Alternatively, the apparent change in color difference with change from daylight to incandescent light gives a lead to the color matcher. The addition of an orange or green colorant can reduce metamerism if the trial "goes red" in incandescent light; a violet or a reddish blue pigment will help a combination that "goes green." This is color matching at its best.

Principle 12 - Preparation of Samples - Reproducibility

The most important part of any training will be to learn how to make samples in a reproducible manner. The instrument-computer should be used to check any process and/or person involved with making samples. Reproducibility should mean that when samples are made at different times, the measured color difference between them should be small. After all, only the best sample preparation will avoid imponderable problems which defy solution. Included in reproducibility is the need to care for an instrument which can be a critical part of any observed variation. Instrument makers give good tools that should be used to check and adjust equipment to avoid bad data.

Preparation of sets of primaries on individual colorants used in instrumental color formulation is a special case. Although there are differences in the approach used by various formulation programs to establish the basic K and S data, the key to understanding whether the data for formula prediction is both accurate and precise. A simple procedure is to duplicate sets of primaries at different times; this includes tints, shades, and mass tones. This checks the reproducibility. Additional information is gained from a ladder of several let-down concentrations of pigments rather than single levels. Examination of the spectral curves can show contamination or inconsistencies. A plot of K/S versus concentration will indicate other possible errors. The final test of accuracy of primary data is to predict the formula of a known sample. The novice will begin to appreciate the need for care in sample preparation if his results are not what is expected.

*BOOKS

No discussion about training would be complete without a list of reference material. Only four of many texts on the subject of color science are given here. Each emphasizes the particular view of the authors but the information is basic and can answer many questions as they arise if these are v\available on a handy bookshelf.

F.W. Billmeyer and Max Saltzman, Principals of Color Technology, 2nd Ed., John Wiley& Sons, New York (1981)

F. Grum and C.J. Bartleson, Eds., Color Measurement, Volume 2, in Optical Radiation Measurements, Academic Press, New York (1980)

D.B. Judd and G. Wyszecki, Color in Business, Science and Industry, 3rd Ed., John Wiley, New York (1975)

R.S. Hunter and R.B. Harold, The Measurement of Appearance, 2nd Ed., John Wiley, New York (1989)

**Editor's note: These references are outdated. The Billmeyer book is in its 3rd edition and another handy book is: Coloring of Plastics, Fundamentals, 2nd Ed., Edited by Robert A. Charvat*

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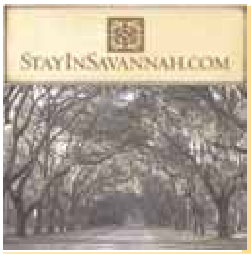

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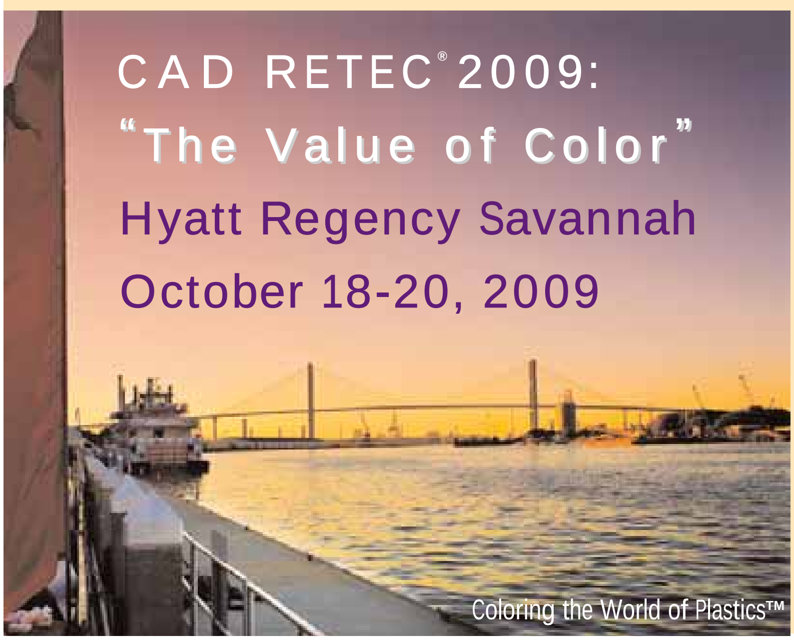

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Back to the Basics of Organic Pigments: Diketopyrrolopyrrole Pigments as the Model Organic Chromophore

by Roger A. Reinicker *(Ciba Specialty Chemicals)*

Since this paper is meant to cover some of the fundamentals of organic pigments, let the start be a thorough understanding of the title itself. First, it is necessary to appreciate that of the entire universe of the color experience we are going to try to understand just a few points about a very small subset of this experience: small, solid, usually crystalline particles which remain insoluble when put into plastic and which selectively absorb light of certain wavelengths (hence appearing to have color).

Second, what do we mean by organic? Organic means containing as a basis the element carbon, but then some carbon compounds are excluded. Perhaps this isn't the best of definitions, but a full explanation could be quite lengthy. Inclusion of other elements is necessary to create colored compounds. For the organic colorants, the most likely other elements present are nitrogen, oxygen, and hydrogen, followed by a raft of others such as chlorine, fluorine, bromine, sulfur, calcium, sodium, barium, strontium, nickel, copper, and cobalt. Despite the presence of metals such as copper and nickel, compounds containing these can still be termed organic.

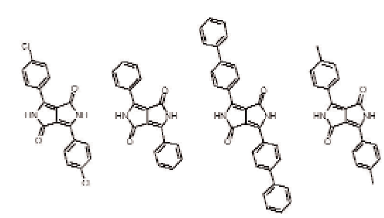
What about the term chromophore? Well, something in the organic compound has to be responsible for creating the color by the selective absorbancy of light. The chromophore is simply the part of the molecule that is responsible for that absorbancy. Not all of the parts of the molecule participate equally in this function.

The easy part of the title is diketopyrrolopyrrole: this is simply a particular chromophore which for the rest of the discussion will be abbreviated as DPP. The simplest molecule which has a DPP chromophore has the chemical formula $C_{18}N_2O_2H_{12}$. This is not a very big chromophore; in comparison, some other molecules about this size are common sugars and calcium stearate, the latter of which might be used in your laboratory or plant as a dispersant or lubricant in the compounding of plastics.

The last part is the word model; why is DPP a model chromophore? DPP is a good model for the organic chromophores because many of the properties of chromophores and the pigments which are derived from them are exhibited by the family of colorants generically called the DPP's.

A Family of Colors

Figure 1. Chemical Structure of Four DPP Molecules



CI PR254 CI PR255 CI PR264 CI PR272

DPP is best known for being red, and a particular generic chemistry called CI Pigment Red 254 is the most well known of the whole family. It is considered by many to be synonymous with the word DPP. As sometimes happens, the first DPP was actually an unwanted by-product of a laboratory experiment and the chemist was looking to make 115 2 something else.[1] But since this discovery in 1974, inventors have used the basic DPP structure to create a range or family of color products by differentiation; substituting chlorine for hydrogen, or using a phenyl or a methyl substitution. Of the dozens of known compounds, only a few are useful as industrial colorants; we can imagine that many others fail to make the grade because they are difficult to make in commercial processes, use rare or expensive raw materials, or simply don't have the very best application properties that are needed to compete in today's market. Figure 1 shows the chemical structure of four of the DPP's.

This family behavior of the DPP is typical for organic pigments. Many other pigment families exist such as azo, disazo, naphthol, anthraquinone, perylene, and quinacridone. Many more compounds exist than are currently commercial, and only the best stand the test of time to be industrially important. The complete family of DPP now encompasses shades from rubine through orange with seven generic names. From most bluish to most yellowish these are PR264 *(rubine)*, PR254, PR255, PR272 *(yellow shade red)*, PR283, PO71 *(yellow shade orange)*, and PO73 *(mid shade orange)*.

The DPP colorants have achieved immense commercial importance not only for their utility in plastics but also in other systems, particularly paints and coatings. As a class, they are quite chromatic *(or bright)* colors and are often either better hiding or of greater transparency if required than other chemistries in the same area of color space. They generally have among the highest heat stability of all organic pigments available, and a number of products based on the PR254 chemistry that have high purity are cleared for indirect food contact use by the US Food and Drug Administration.[2] Physical and chemical structure manipulation has also led to products which disperse easily and predictably or allow minimal warping after injection molding .

1. A. Iqbal, L. Cassar, A.C. Rochat, J. Pfenninger, and O. Wallquist, New Heterocyclic Pigments Journal of Coatings Technology, March 1988, JCTAX 60 (758) 1-92 (1988) **2.** Not all PR254 products are FDA cleared. FDA clearance generally depends upon a product's composition and resistance to migration and in some cases constancy of a manufacturing process.

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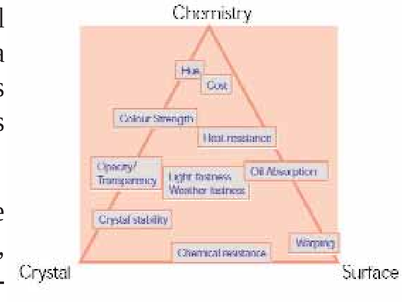
Physical vs. Chemical

Chemistry alone is only part of the story about being a model chromophore[3]. Knowing the chemistry, the chemical structure, of an organic pigment will not allow the working properties to be predicted or understood. To understand the remainder of the properties requires knowledge of the pigment crystal and how this crystal interacts with the plastic with which it is in contact. This means that a pigment shows the properties of a chemical compound - the chromophore, the properties of a solid state body - the crystal, and also the properties coming from the interfaces between this body and the substrate.

Figure 2. Triangle of Properties



Thus, all pigment properties can be summarized in a triangle where the corners are the chromophore, the crystal and the surface interfaces (Figure 2). We've done the first part, the top of the triangle. According to the triangle the chemistry is the vehicle for understanding the hue, the intensity of the color, and also a lot about what the pigment will cost. Certain fastness properties such as fastness to heat, light, and chemicals are also determined here, at least in part.

DPP pigments have a particular hue because of the pattern of absorption of light *(electromagnetic radiation)* by the molecule. Electrons are boosted from a ground state to an excited state by absorbing specific bands of energy. The DPP molecule behaves differently in this regard from the DPP particle because in a particle or crystal the molecules line up in a specific, ordered pattern and absorption changes. DPP molecules in solution are most often fluorescent and the hue is significantly shifted yellow compared to the crystals. If DPP's did not form the well-ordered compact crystals that they do, the chemistry would have little value at all. The symmetry of the molecular structure seen in Figure 1 is the source of the DPP's success; an imagined rotation of 180 degrees about the central carbon–carbon bond gives the same configuration back again. This symmetry allows the well-ordered crystalline structures to be formed.

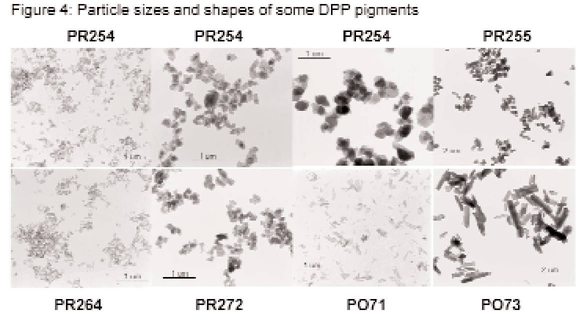
Figure 3: DPP Heat Stability in HDPE

	Heat Stability, Masstone	Heat Stability, Tint
Concentration (pigment + TiO_2)	0.10%	0.1% + 1.0%
Pigment Orange 71	300°C	300°C
Pigment Orange 73	300°C	270°C
Pigment Red 254 (opaque)	300°C	300°C
Pigment Red 254 (transparent)	280°C	300°C
Pigment Red 255	240°C	240°C
Pigment Red 264	300°C	300°C
Pigment Red 272	300°C	300°C
Pigment Red 283	300°C	300°C

In the triangle representation, heat stability is determined largely by the chemistry. For the commercial DPP's, heat stability varies over a range from about 240°C to about 300°C *(and even up to 340°C in some cases)* and often allow multi-stage recycling depending upon the exact chemistry. Figure 3 shows that two different types of Pigment Red 254, an opaque type and a transparent type, have only slight heat stability differences. This is typical for a single chemistry; different versions, in this case larger opaque or smaller transparent types, vary little in this fastness property. There is an exception to this rule in the case of pigments which are polymorphic or which can exist in different crystal forms, such as CI Pigment Violet 19 and Pigment Blue 15, to name just two of the best known examples. In this case, especially if one of the forms is preferred thermodynamically, heat stability dramatically with crystal type. For the commercial DPP's, polymorphism has not been a major consideration. Pigment Red 254 has been reported to exist in two different crystal morphologies conveniently called the alpha and the beta form with the alpha form being the more thermodynamically stable, but again this has not been an important commercial consideration.[4]

A further understanding of the triangle is that pigments are made as crystals with a particular size and shape. Not all the particles in a given product will have the same size, however, although that would be ideal. Instead, most products have a range of sizes. The crystals tend to clump together either in the process of making them or in the process of isolating them from the other products and materials that are part of the reactions that make them. DPP's have a variety of shapes and sizes and in this way are very much like other chromophores. Figure 4 shows electron micrographs of some commercial DPP's and a wide variety of shapes and sizes is evident. This is very typical of organic pigment behavior; even within a single chemistry many shapes and sizes may be represented.

Figure 4: Particle sizes and shapes of some DPP pigments



3. For this discussion I am indebted to Philippe Bugnon, RETEC® 2002, "Innovative Coloring Solutions for the Plastics Industry"

4 High Performance Pigments, Hugh M. Smith (ed), Chapter 11 DPP Pigments p. 175, 2002.

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Particle size and shape are important in determining the best applications for a particular product. Larger particles are more lightfast and weatherfast for most organic chemistries, including the DPP's. Figure 5 show how there is a significant increase in weatherfastness with particle size for PR254. Smaller particles offer higher chroma when put in combination with a scattering pigment such as titianium dioxide, but larger particles will have higher chroma in self-shade masstones. The coloring power that comes with smaller particles is not a universal advantage. Previous papers presented at SPE RETEC® have shown also the differing values of transparent and opaque particles in formulating opaque, transparent, and translucent articles and moldings.[5]

Figure 5: *WEATHER RESISTANCE AS A FUNCTION OF PARTICLE SIZE OF PR254*

Pigment Red 254 particle size	0.1% pigment in HDPE plaque, 3000 hours weather resistance, gray scale
small	2-3
medium	4-5
large	5

Surface

The last part of the triangle is the surface of the pigment particle. This is an important area for looking at applications and also for process considerations. Figure 6 lists the specific surface area for several commercial DPP's. Generally speaking, the lower surface area products will be less likely to clump together and therefore might usually be easier to disperse. The higher surface area products are more transparent. It has been recognized that the pigment-polymer interface also is the source of interactions such as warping and nucleation which affect organic pigment use in semi-crystalline polymers such as polypropylene and high density polyethylene. For the majority of plastic uses which involve solid dispersions the effect of large surface area pigments with regard to viscosity is not much of an issue. For paints, this is not the case and there exists a great deal of technology that explores this relationship. The surface plays an important role in liquid dispersions for plastics – liquid colors, pastes, and plastisols for example.

Figure 6: Specific surface areas of commercial DPP's

Pigment CI Name	Surface Area, m^2/gram
Pigment Orange 71	79.5
Pigment Orange 73	20.8
Pigment Red 254 (opaque)	19.9
Pigment Red 254 (semi-opaque)	28.7
Pigment Red 254 (transparent)	93.8
Pigment Red 255	15.4
Pigment Red 264	95.4
Pigment Red 272	37.6

Some practical Considerations - Working with the DPP's

Let's say you are putting together a formula in the laboratory or plant that calls for a DPP pigment to be used. What form are you likely to find it in? The most likely form will be the powder form because more is sold of this form than any other, and it is almost always the precursor to other forms. In other words, the different forms that the products are found in, such as concentrate pellets, prills, pastes, beads, granules, or even liquid, start with the powder first. The powder is the most universal since the other types will contain other additives *(resins, dispersing aids, carriers)* that are used to create the value-added new form. Each time another component is present there must be a consideration that this additive is not appropriate for some applications

Which form is the best? This can't be answered simply. Each type has its advantages and disadvantages as illustrated in Figure 7. Figure 7 represents just the author's opinion and should not be taken as absolute. Purveyors of each form are well able to tout their own product's advantages. The importance of product form has to do with getting the value out of the pigment that has been put there by the manufacturer. There are of course many values such as FDA compliance, heat stability, and chemical resistance, but one of the most important is being able to disperse and distribute the pigment to take advantage of its inherent coloring power. Is it necessary to break down the pigment so that in the application it is present as in Figure 4 and which product form is likely to do that? For most all plastics applications, it isn't necessary to go that far. One might think that starting with the powder might work best since it is most likely to have the particle size distribution close to the pictures. Actually, the product in the bag or box or drum that is purchased is already quite unlike the particles in the picture. A calculation shown in Figure 8 for settling time of a particle of the density of a DPP indicates that if the particles were of the size shown in the figures they would quickly become airborne when handled and would take literally days to settle. Clearly this is not the case, and only a few particles of the raw powder are of this size. The rest are present as loosely joined agglomerates or more tightly packed aggregates. In Figure 7, all the forms except the dry toner represent some dispersive work, hence dispersion effort will be the greatest with dry toner and least with the most value added form of color compound. What you gain with the value added forms is convenience and security of dispersion properties. What you gain with the raw powder form is flexibility and low cost.

Figure 7: PRODUCT FORMS

	Cost	Dispersion Effort	Dusting	Polymer Flexibility	High LDR	Metering Costs	Color Uniformity	Clean-Up	Inventory Space
Dry Toner	++	--	-	++	-	-	-	--	+
Single Pigment Dispersion	-	+	+	-	+	+	+	+	-
Custom Color Concentrate	-	++	+	--	--	+	+	+	-
Pre-color or Compound	--	++	+	-	NA	NA	NA	+	--
Liquid Color	+	++	+	-	+	++	++	+/-	+
Flush (wax)	+	+	+	+	+	+	+	+	+

5 Marie Odile Zink, RETEC® 2004, "The Value of Transparent and Opaque Pigments in Plastics Coloration"

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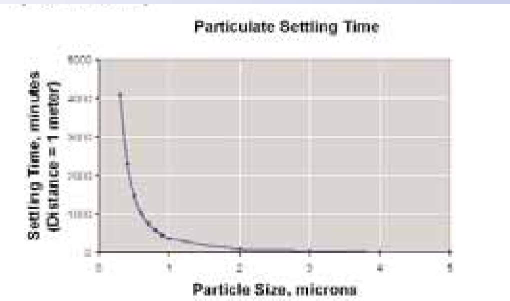

Another very practical consideration is the range of polymers that exist in the market as opposed to the available literature on the performance properties of the DPP's in different plastics. What if the polymer of my particular application has isn't listed? How will the performance properties of the DPP's vary with polymer type? The most common situation with DPP chemistry that should concern users is that of solubility. Solubility is quite easy to understand: the particles created in manufacturing may dissolve in the substrate as a function of the aggressiveness of the solvent, degree of mixing, residence time, and temperature. Solubility will cause a loss of key properties *(hue, lightfastness, migration, for example)*. In essence, two legs of the triangle of properties are destroyed when the crystal is dissolved, leaving only the chemistry to determine all properties. In the beginning of the paper it was mentioned that the DPP's shift yellow and fluorescence in black light when they are in solution, hence it is relatively easy to tell when this phenomenon is occurring. It is also easy to comprehend that reducing the factors that cause dissolution will improve application performance and that in many situations the performance will be completely satisfactory even if a small portion of the DPP is dissolved. Hence, the DPP's are working satisfactorily in nylon, for example, despite the aggressiveness of this polymer.[6]

New Generic Chemistry of DPP

There has recently been an influx of new DPP pigment products to the commercial market, most of them focusing on the well known PR254 chemistry and most taking advantage in one way or another of the rules of behavior with respect to particle size in order to be differentiated from existing products. However, DPP chemistry is not static with regard to new generic types.

Figure 9. Schematic Positioning of the new PR283

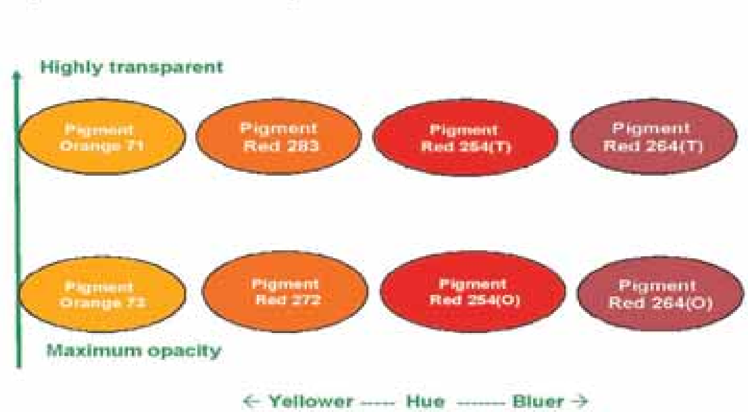

Figure 10: PR283 Properties

Property	Pigment 283 Value
hue	*saturated yellow shade red*
opacity/transparency	*very transparent*
1/3 ISD	*0.14g (with 1% TiO2)*
dispersion	*FPV <1.0 bar/gram acc. EN13900-5*
nucleation/warping	*non-nucleating, low-/non-warping*
suitable polymers	*polyolefins, PVC*
types of processes	*injection molding, blow molding, films, sheet, PVC calendared films, spread coatings*

Pigment Red 283 is the newest member of the DPP family, becoming a commercial reality this year. As with most of the family, it exhibits high heat stability and brightness of shade. It has been created to fill a void in color space as displayed schematically in Figure 9. PR283 has similar hue to the existing PR272 and is stronger in tint, higher in chroma, and considerably more transparent than the PR272 that was optimized to provide optimal hiding power for masstones. Additional key properties are listed in Figure 10. PR283 is expected to be valuable in transparent stylings with effect pigments and effectively bridge the gap between existing DPP reds and oranges due to its high chroma. Most importantly, this pigment has been found to have non-nucleating behavior in olefins which means it will have minimal effect on the dimensional distortion or warping of high density polyethylene moldings.

Conclusion

The DPP chromophore and the range of products it represents are a good model for understanding the basics of organic pigments. The DPP's offer a full family of diverse colorants, with diversity in chemistry, crystals, and surfaces. Chemistry alone does not define a pigment. The properties important in processing and application come from the three legs of a triangle including the chemistry, the crystal, and the surface.

DPP's are still an active area of research and development. New chromophores and crystal modifications are filling holes in the current palette and extending the region of color space available to the plastics industry.

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