VINYL NEWS

CHAIRMAN'S MESSAGE

ORLANDO – THE CITY BEAUTIFUL – LAKE EOLA

ANTEC 2015   MARCH 22-25

JOINT WITH NPE

VINYL PLASTICS DIVISION BOARD MET OCTOBER 22

Vinyl Division Meeting
October 22, 2014

This Meeting was held during lunch on Wednesday, October 22, 2014, at Vinyltec 2014. Dave Peeples called the meeting to order and welcomed everyone in attendance. He thanked everyone for their participation and explained the purpose of the meeting. He reported that the Vinyl Division had 592 members and at least 41 new members and renewals had been added at Vinyltec 2014.

Dave then introduced Emily McBride as the TPC Chair for 2014 Vinyltec and Kasper Van Veen as the TPC Chair for 2015 Vinyltec in Akron

The TPC Members were recognized as were the BOD Members. Volunteers were requested for both the TPC and the BOD. After the meeting John Scott was added to the TPC. There were no new volunteers for the BOD. BOD elections will be held shortly after the first of the year.

Requests for Vinyltec 2015 recommendations were solicited as were volunteers to help design and prepare the new Vinyl Division website. Peggy Schipper will lead this effort.

ANTEC 2015 will be held in Orlando in combination with NPE (3/20/15 - 3/22/15) and we requested suggestions for increasing participation and the number of ANTEC papers.

Dave provided a short Financial Status update.

The membership was provided with short review of the Society's and Division's awards:

a. Technical Contributions to Vinyl – Paul Daniels
b. Outstanding Service – Sylvia Moore
c. SPE
    1. Honored Service Member
    2. Fellow

Alan Gibb handed out awards:

a. Technical Contributions to Vinyl – Paul Daniels
b. Outstanding Service – Sylvia Moore
c. ANTEC 2014 Best Student Paper - Ian Query
d. ANTEC 2014 Student Advisor - William Arendt
e. ANTEC 2014 Best Paper - Sean Fowler
f. Vinyltec 2013 Best Paper - James Summers

The meeting was adjourned.

Bruce Mulholland presents Introduction to Color Theory

INTRODUCTION TO COLOR THEORY

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Abstract

The very basics of our visual color perception process and instrumental color assessment will be discussed in this brief overview.

Introduction

People usually associate color with physical objects that are viewed in sharp contrast to their surroundings: be it a beautiful flower arrangement, or a colorful spinnaker on a sailboat against a dreary gray sky. In addition to colored objects, color is also associated with creating overall visual impressions which set certain moods, tell the time of day, or indicate certain climates or temperature. Furthermore, color can be used to create emotions or stimulate feelings such as artist's colors in paintings and a designer's choice of colors in decorating a room.

But to us in the plastics industry, the coloring of an object is most important. The purpose of this paper is to provide a very brief overview of how objects are colored, and how we as observers perceive their color. What is presented herein not only applies to coloring plastic resin, but also applies to all colored media including textiles, paints, ceramics, inks and so on.

Visual Color Perception Process

In order to experience color, three things must be present: a light source, an object and an observer. The color perception process occurs as follows. A beam of light from the source reaches the surface of our object. A portion of the light is reflected due to the surface interface and is called the specular reflection or gloss component. The gloss is reflected in an angle equal in magnitude to the angle of incidence of the light beam, but opposite in direction. The gloss component contains all wavelengths of the light source. Therefore, if the light source is white light, the gloss component will also be reflected as white light.

The remainder of the light penetrates the surface of the object where it is modified through selective absorption, reflection, and scattering by the colorants, polymers and additives. Selective absorption and reflection by wavelength create color. For example, if an object absorbs all wavelengths from a white light source other than blue, nothing will happen to the blue light component of the light source, and the blue light will be reflected or transmitted from the object. The observer will see this reflected or transmitted blue light and we say that the object appears blue.

To fully understand this process, it is important to discuss the three items needed for color more completely. All three -- the light source, object and observer, are governed by sciences applicable to their functioning. Light sources operate in the visible region of the electromagnetic spectrum and therefore can be described using physics. The object modifies the light using the chemistry of the colorants and other ingredients which absorb, reflect or scatter the light. The physiological construction of our eye determines our ability to respond to the stimulus from the object. Finally, psychology governs how the brain interprets the energy from the eye and transforms it into our perception of the color.

The Light Source

Obviously, the light source plays a major role in the color we perceive. Light is nothing more than electromagnetic radiation similar to radio waves and other energy. Light is different because our eyes happen to be sensitive to this particular energy and can be seen. All electromagnetic energy travels in waves. A wavelength is defined as the length of one wave unit measured from peak to peak. The wavelength of the electromagnetic radiation is an indication of the amount of energy contained in it. The shorter the wavelength, the higher the energy content in the radiation.

Long wavelengths exhibit relatively low energy. Examples of these include radio and television transmissions which have a wavelength of over one meter. Shorter wavelengths of about one millimeter in length begin the infrared region. We know this is higher energy because heat is generated at these wavelengths. The visible light region is next, with wavelengths generally defined as 400 to 700 nanometers. The visible region will be discussed later in more detail. Energy continues to increase as the wavelengths become shorter. Just shorter than the visible region are ultra-violet wavelengths. These show their higher energy by creating sunburn on skin or causing UV degradation of plastics. Shorter and shorter wavelengths of one angstrom and less create the highest energy sources of X-rays, gamma rays and cosmic rays.

The visible region contains all possible wavelengths of light described commonly by hue. The 700nm end is the color red. Orange appears between 590 and 630nm. Yellow is slightly shorter between 560 and 590nm. Green light occurs next between 480 and 560nm and blue is the shortest wavelength below about 480nm. The energy corollary holds in the visible region as well. Blue is shortest in wavelength and therefore should be the highest energy. If one thinks of fire, it is true that a blue flame is hotter than an orange or red flame, and thus exhibits higher energy.

In considering the visual color perception process, light sources that are comprised of all of the wavelengths of the visible region are most useful. These light sources will emit white light and include such sources as the sun, filaments of light bulbs, and fluorescent lamps. But we know from experience that colors can look different whether viewed under a 60W light bulb or outdoors under the bright sun. This is called color rendition or the color rendering effect of the light source. Furthermore, there are other light sources such as mercury vapor lamps which appear nearly white, but do not contain all possible wavelengths. Therefore, it is important to know how much energy, if any, is present in the light source wavelength by wavelength. This can be measured and is called the spectral energy (or power) distribution of the light source.

We previously stated that our visual color perception is dependent on the object modifying the light from the source. Thus, the spectral energy distribution is important to understand and control in color matching. In that earlier example, we stated that the object would appear blue since no modification was done to the blue wavelengths and the object reflected blue light which was seen by the observer. However, if the light source was a red light which contained no blue wavelengths, then obviously the object could not reflect blue light and we could not perceive the color of it as what we call "blue". Moreover, our object could potentially be perceived as being bluer in color viewed under a cool white fluorescent lamp or sunlight compared to being viewed under a 60W bulb. Fluorescent light contains more blue light energy compared to the 60W bulb. Our object would then have this higher amount of energy in the blue region to reflect back to the observer.

This whole discussion stresses the importance of standardizing the light source for viewing color. Manufacturers of color viewing booths and light sources generally describe their light sources in terms of color temperature. Common sources include tungsten filament at 2854K (CIE Source A), cool white fluorescent at 4200K and north daylight at 6500K. Thinking back to our energy corollary, the higher the color temperature, the bluer the light source since blue wavelengths are the highest energy. And while color temperature is used to describe sources, it is important to point out that the spectral energy distribution is really what is important for our color perception and that the color temperature does not explicitly define this. The spectral energy distribution is the amount of energy present in the light source measured at each wavelength in the visible light region. Examples of spectral energy distributions are shown in Figure 1. Two light sources may measure as 6500K, but their spectral energy distributions could be different giving rise to differences in perceived color under each.

What's more, color measuring instrumentation generally report color difference under illuminant D (6500K) and others. These illuminants are mathematical descriptions of a light source defined by a numerical spectral energy distribution. D6500K, for example, is defined by the spectral energy distribution of average, natural daylight and can not be duplicated artificially. Therefore, 6500K in a light booth, and D6500K used to calculate color data by an instrument do not have the same spectral energy distribution so colors may "appear" somewhat different under each.

The Observer

The most important color observer is the human eye. This is true in any industry that relies on a product which is colored, or is packaged or labeled with color. While sophisticated color measuring instruments are used in industries to control color, the ultimate consumer, you and me, uses his or her eyes only to judge and observe color.

We perceive color by our eye's ability to detect the light reflected or transmitted from the object. The lens in the eye focuses the light on the retina at the back of the eye. The retina contains two types of light detectors – rods and cones. Rods are responsible for our night vision, but are not involved in our color perception. That is why, in very dim light, we can see but most objects appear black or various shades of gray.

Cone receptors are what give rise to color vision. Current thinking is that there are actually three types of cones: one type that is sensitive to red wavelengths, one sensitive to green, and the other sensitive to blue. The individual responses of these cones are combined by the brain to generate the sensation which we describe as color. The mechanism of how these responses are combined is very complicated and is not critical to our understanding of color perception. It is important to realize, however, that the brain's ability to interpret these responses can be influence by psychological factors, and thus alter the perceived color of the object. The old adage of seeing red when you are mad can be true and is an example of this. The object, light source, and your eye's physiological construction have not changed. What has changed is the way the brain combines and interprets the responses from the cones, and you perceive things to be redder than they would normally appear.

The primary cause of differences of color perception between human observers generally is due to physiological differences in construction of the eye. These differences can be hereditary, or attributed to injury or the aging process. The aging process typically causes the macular fluid in the eye to yellow. The light reflected from the object travels through this fluid before it reaches the cones on the retina. Color bodies in the macular fluid may act as a filter of sorts, absorbing some of the reflected light, and can change our perceived color of an object over time.

Injuries to the eye directly or to the head can be catastrophic causing complete loss of vision. Less severe injuries could lead to detached or partially detached retinas or damaged cones which could alter our perceived color of objects.

By far the greatest factor in causing human observers to perceive colors differently is physiological differences which are hereditary or simply inborn. Knowing that there are two general types of cells – rods and cones, and three specific types of cone receptors on the retina, it becomes easy to rationalize that no two people can have the exact distribution of these receptors on their retinas. Therefore, all individuals must perceive color slightly different because of this.

People that exhibit gross differences in cone distribution or functioning are typically referred to as colorblind. This is a misnomer in that colorblind implies seeing no color and only shades of gray. While there are a very small fraction of the population who are actually colorblind by that definition, most people claiming they are colorblind are actually color deficient. These people with color-deficient vision see color, but their perceived color is not normal by definition. About 8% of all males, and only about ½% of all females, have some degree of color-deficient vision. The most common is called deuteranopia (or the less severe anomaly deuteranomaly) which is a red–green deficiency. Up to 5% of all males have some degree of this. Deuteranomaly accounts for the majority of all female color deficiencies. Complete red blindness (protanopia) or the anomaly protanomaly (red weak) are the next most common deficiency occurring from 1 to 2% in males. Yellow–violet lacking tritanopia or the corresponding anomaly tritanomaly (blue weak) are the rarest forms for both sexes.

This discussion should make it clear to the reader that persons placed in a position of making visual color decisions must be tested to ensure they have normal color vision. This can be accomplished by having them perform at least one of the color aptitude tests commercially available today.

The Object

While the light source and observer discussions above are strictly generic to any industry, discussions of the object become very industry specific. For us in the plastics industry, the object is typically a formed plastic article. As stated earlier, the light from our source penetrates the surface of the object where it is modified through selective absorption, reflection, and scattering by the colorants, polymers and additives. For transparent or very translucent articles, reflection is either replaced by or supplemented with light transmission. For simplicity, we will assume opaque articles and just discuss reflectance.

Objects are typically colored by incorporating pigments or dyes (colorants) into the polymer matrix. Colorants act on the incident light by selectively absorbing certain wavelengths. This is determined by the specific chemical bonds within the colorant structure. Chemicals are useful as colorants as long as these bonds absorb electromagnetic energy within the visible region. Iron oxide is a useful colorant because the compound typically absorbs blue and green wavelengths of light. Red wavelengths are not modified; therefore, this colorant appears red due to the reflected red light. It is helpful to remember that the perceived color of a pigment or dye is due not to what the compound does to the wavelengths of that dominant hue, but rather to all of the other wavelengths. In our example, a red pigment acts on blue and green wavelengths, and not red.

For the most part, the colorants themselves do the majority of the absorbing of the incident light by wavelength to create color. A few polymer additives can impart a yellowish color by absorbing some blue light. The polymer matrix can also do this. Other additives, particularly mineral fillers, can impart a grayish or brownish color due to light absorption.

Polymer matrices and additives can, however, contribute significant light scattering. Scattering occurs when the light beam contacts particles or regions with refractive indexes different from that of the polymer. If scattering occurs equally at all wavelengths with no absorption, the object will look white. The amount of difference information can be obtained by comparing tristimulus values directly.

Tristimulus values are however important because they represent the fundamental mathematical description of color. And while there may be problems in describing the standard observer, and problems using illuminants that don't physically exist (D6500 for example), tristimulus values are building blocks for more meaningful numerical color description and color difference characterization. Researchers over the years have applied non-linear transformations to tristimulus values with the goal of creating uniform color spaces which allow calculation of color difference magnitude and direction. The most common transformations used today are HunterLab, CIELab, and the CMC equation. These equations give us color coordinates that are widely used in industry such as:

- L: Lightness
- a: Red/Green
- b: Yellow/Blue
- DL: Light(+) / Dark(–) difference
- Da: Red(+) / Green(–) difference
- Db: Yellow(+) / Blue(–) difference
- DE: total color difference

It is extremely important when reporting these numerical color values to explicitly define the parameters used to obtain the values. Reporting that the DE was 0.7 is meaningless unless all of these parameters are defined and understood. Therefore, all color data must be reported with the definition of the illuminant, standard observer, color space or units, and preferably with the geometry of the instrument. An example of the required information is "Color data calculated under Illuminant D65, 10° Observer, Sphere Geometry, Specular Included, Expressed in CIELab units."

References

1. W. Billmeyer, Jr. and M. Saltzman, Principles of Color Technology, 2nd ed., John Wiley & Sons, New York, (1981)

Key Words

- Color perception
- Color theory
- Color assessment

Figure 1

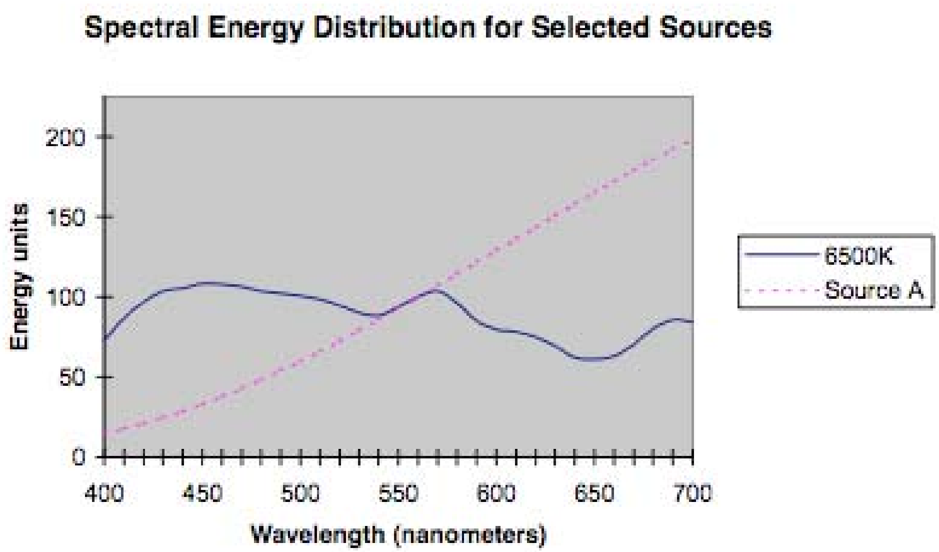


Figure 2

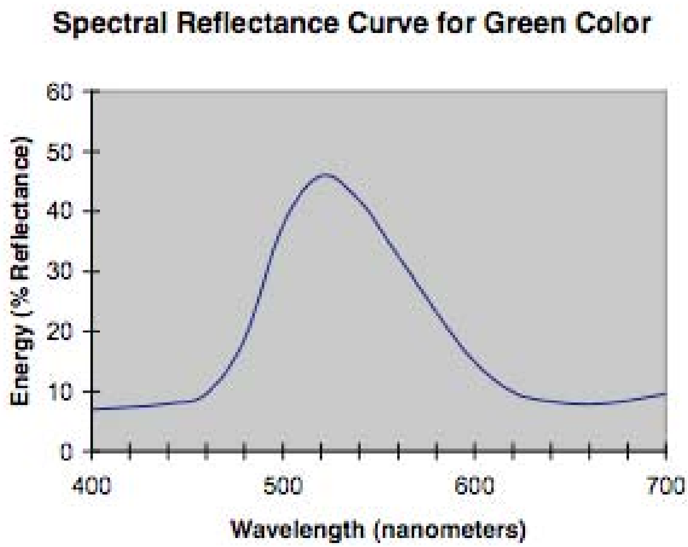
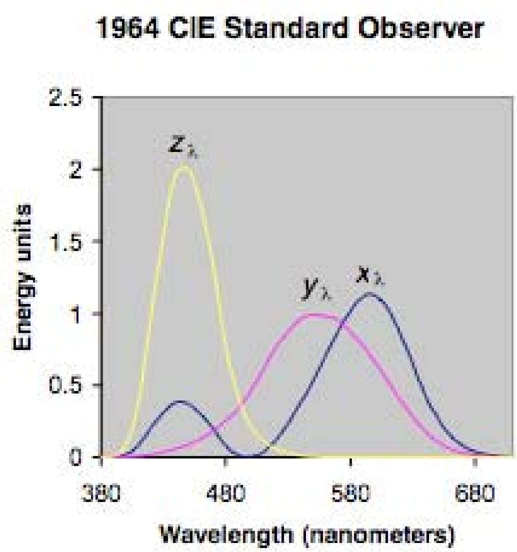


Figure 3



Minutes –Vinyltec 2014 Meeting
Monday, Oct 20, 2:00 PM – 3:30 PM Board Room, 6th Floor
Alexander Hotel, Indianapolis, IN

1. Approval of minutes from ANTEC Meeting April 2014
2. Update Membership Roster - circulated ahead of time for updates
    a. Move Len to emeritus status
    b. Updated Burch Zehner's email address (burch.zehner@cpgbp.com)
3. Officers
    a. New Chair – Kasper Van Veen nominated for chair
    b. TPC Secretary 2014-2015 – Bill Kuhn nominated for secretary
    c. Term to start at the end of Vinyltec 2014
    d. Tara Smith volunteered to act as secretary for 2016
4. ANTEC 2014 – Review
    a. Best papers ANTEC 2014 – Sean Fowler (46 attended)
    b. Student Paper ANTEC 2014 – Ian Query (33 attended)
    c. Elliott Weinberg Award – Xianlong Ge (22 attended)
    d. Two joint sessions – with PMAD and EPSDIV (Don Witenhafer Memorial)
    e. Wine & Cheese Reception (joint with PMAD and EPSDIV)
        i. Room was HUGE
        ii. No signage, had to hand-write signs to direct attendees
        iii. Several entrances to room, so hard to hand out drink tickets
5. 2014 Vinyltec
    a. As of 10/15, about 180 registrants and $100K gross revenue
        i. How many new memberships through sign ups at Vinyltec?
    b. Issue with original lunch location (restaurant) and AV availability, so compromised with lunch served in the ballroom
    c. 20 minute schedule allowed for 31 presentations in the two day main session schedule (not including lunch speakers)
    d. New ideas
        i. Hall of Fame poster/memory board(s)
        ii. Recycled vinyl bags w/handouts
        iii. Wednesday night event (couldn't pull together in time, but good idea nonetheless)
    e. Blast about Vinyltec on LinkedIn/social media
        i. Set up LinkedIn for presentation questions
6. Review Moderator Guidelines
7. Awards
    a. The Weinberg Award Winner - Ge
    b. Best Student Paper – Query, student; Arendt, advisor
    c. ANTEC Best Paper – Fowler
    d. Nominations for 2015
        (1) SPE Awards (need at least one of either HSM or Fellow to qualify for Pinnacle Award)
            (a) Honored Service Member
                (i) Need champion to submit application
                (ii) 2014 – Roman Wypart, submitted
                (iii) New 2015 nominees – Bob Weiler (Tom Tettamble as champion)
            (b) Fellow
                (i) 2014 – Bob Paradis – application submitted
                (ii) 2015 – Mark Lavach – application submitted by Palisades Section, need Div. Critique
                    1. Will be joint submission w/Vinyl Division for 2015
                (iii) New 2015 nominees?

(2) Vinyl Division Awards – Move discussion to Thursday
   (a) Outstanding Service
      (i) 2014 – Sylvia Moore
      (ii) New 2015 nominees?
   (b) Technical Contribution to Vinyl
      (i) 2014 – Paul Daniels
      (ii) New 2015 nominees?

8. ANTEC 2015 – Orlando
   a. As of 10/16, two papers submitted (both UO intern papers from Emerald)
   b. Expecting at least one more from UM
   c. Sent out email request individually to each listed college/university mid-May as well as late August
   d. ANTEC as a whole is suffering low paper submission totals. Only 318 papers submitted as of 10/14, comment was they should have been at 450 at that point.
   e. Moderator volunteer – Dave Owen
   f. Invited paper ideas
      i. K&H on plasticizers
      ii. Intro to plasticizer theory
      iii. Rich Krock?
      iv. Prop 65, Bill Hall
      v. ACC/Phthalate Ester Panel
9. Vinyltec 2015 – Akron –Akron Section
   a. Dates: 10/13 – 10/15
10. Vinyltec 2016 – Palisades
   a. Try to schedule for late September to avoid K Show conflict
11. Vinyltec 2017 – S Texas Section, vote for San Antonio as location
12. Vinyltec 2018 – Indianapolis, Chicago
13. Colleges & Universities
   a. Personally tailored emails in March and August were sent out along with award information
   b. Out of 24 college/university contacts, only one (UM) submitted a paper for ANTEC
   c. Other outreach ideas?
14. Winter TPC meeting
   a. Vinyltec 2015 planning meeting is scheduled for Thursday, October 23rd in lieu of the Winter TPC Meeting
15. New Business
   a. New potential TPC member: Blaire Russel/CCC Plastics
   b. New TPC member: John Scott/Ferro

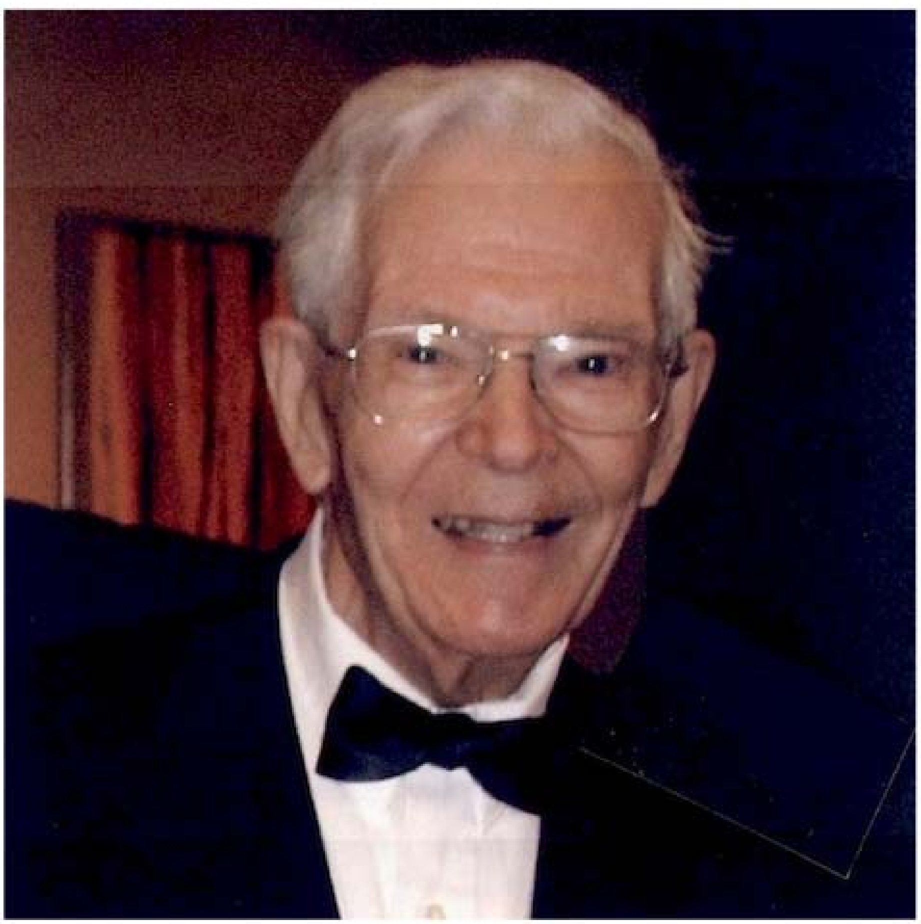
Len Krauskopf lectures on Development of Vinyl

Sylvia Moore receives Outstanding Service Award

Jim Summers follows up Best Paper of Vinyltec 2013
with 50 Years of PVC

We must conclude this issue on a note of sadness. The Vinyl Division has lost an early pioneer and great friend. Alva (Al) Whitney passed away on November 27th at home in Palm Coast, Florida. Al turned 100 on August 8th this year. Since he devoted so much of his life to the vinyl industry, it was fitting that Al reached the century mark at the 100th anniversary of the commercial use of vinyl. Last year the Vinyl Division recognized Al with our first Outstanding Lifetime Service Award.

Al's accomplishments as a leader in the Society and founding member of the Palisades Section are well known. He was a friend and mentor to many in our industry. The Vinyl Division sent a Peaceful White Lilies basket to his memorial service at The Chapel at Hazel Wood Cemetery in Colonia, New Jersey, December 5th. Rest in peace old friend.



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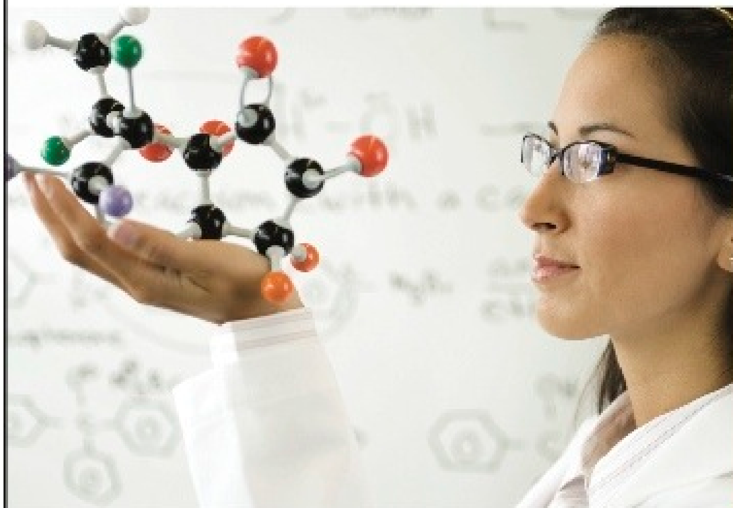

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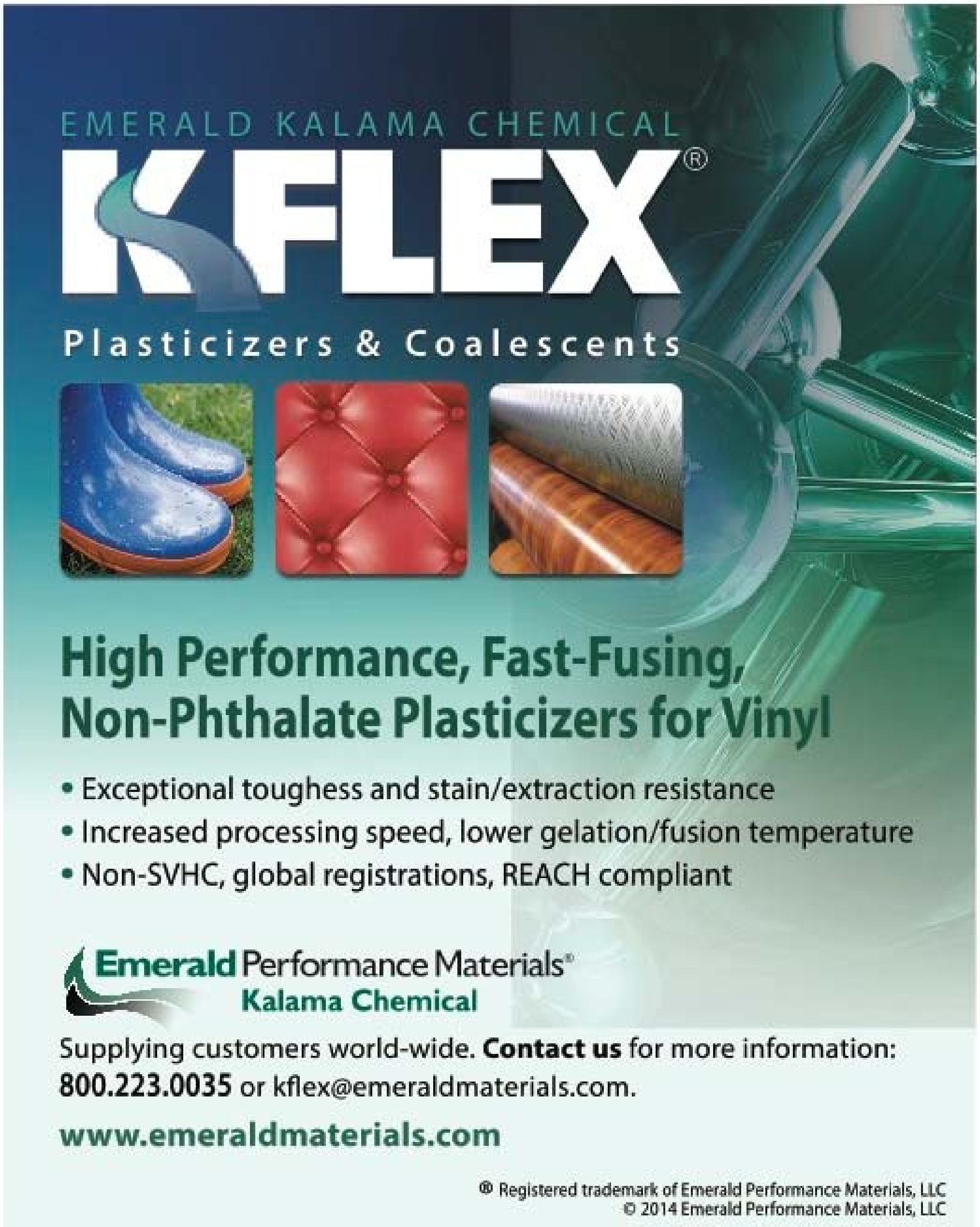
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