

NEWSLETTER



THERMOFORMING division

SOCIETY OF PLASTICS ENGINEERS, INC.

Board Meeting

The next Board of Directors meeting is scheduled for Saturday, March 6, 1982 in The Host International Hotel at the Detroit airport. Agenda items include: nomination of new officers and members of the Board of the class of 1985 for the Division; committee reports; discussion of selection of Thermoformer of the Year award.

Newsletter Advertising Policy

Advertising in Division Newsletters will be limited to insertion of individual or corporate advertising no larger in size than 2"x3½". Such advertising will be grouped in one area of the Newsletter with an introductory statement indicating that these individuals or companies are sponsoring the Newsletter by underwriting publication costs.

Publication in Division Newsletter of display advertising of the type normally associated with professional, trade and commercial journals continues to be prohibited.

Thermoforming Division Guidelines

The purpose of the Thermoforming Division is to foster the development and promotion of thermoforming processes by means of educational activities and the dissemination and interchange of information to its members, the Society, the plastics industry, and the public.

The Goals of the Division are 1. To establish a Board of Directors whose members accept the responsibility for the affairs and activities of the Division. 2. To publish a Division Newsletter for distribution to members and other interested parties. 3. To conduct at least one technical session per year in cooperation with a Section, Division, or with the national SPE, and to develop and present seminars on thermoforming. 4. To make available information and speakers regarding thermoforming to members, other elements of the SPE and the plastics industry, the public.

Activities of this Division will be: 1. Conduct an annual business meeting to provide for input by the membership. 2. Present an award plaque for the thermoformer-of-the-year at the annual business meeting. 3. Present a thermoformed plaque incorporating the SPE and the Thermoforming Division logograms to be presented to ANTEC speakers and retiring Division Board Members and Officers. 4. Present an annual education award to the school that will best use the award to further the teaching of plastics in general and thermoforming in particular. 5. Develop a brochure "This is Thermoforming" with two copies to be sent to each member along with an SPE membership application for recruitment purposes. 6. Present DIV-TEC/RETECs and promote thermoforming seminars.

Chairman's Comments

In May of 1980, at the New York ANTEC, a group of us got together and decided to seek to rejuvenate the Thermoforming Division. We got the wholehearted support and assistance of the SPE. As a consequence, we now have a complete Board of Directors that has met four times, and we have a full slate of officers of the Division.

One outcome of this activity was the successful thermoforming session at the Boston ANTEC last year. We can look forward to another excellent session this year in San Francisco, principally due to the efforts of Jim Throne. Another outcome is this Newsletter, the first in a number of years, which is the principal



Dick Osmers

vehicle for communications within the Division and between its members. Dick Brammer has been the prime mover in this regard. We also have a set of committees, including nominations, standards, technical programs, membership, awards, publications, education, and coordination with the SPI. Each of these is gearing up to handle its respective areas.

In short, we have interest and we have commitment. But it all boils down to opportunity for all of us: opportunity to advance our profession; opportunity to learn more about each other's work and interests; opportunity to convey our knowledge for the betterment of society; and the opportunity to get to know one another better.

To make the most of these opportunities, the Division needs your input, so do give serious consideration to lending a hand when you're asked to do so. If you're not asked soon enough, consider that an oversight and communicate your feelings and interests. All our best efforts are required to maintain and increase the value and momentum of the Division. It is a worthwhile activity.

SPE Donation

The Thermoforming Division has supported the development of a 16 mm movie by SPE on plastics and processing with a donation of \$500, and a 35 mm slide presentation for educational purposes with a donation of \$300.

SOCIETY OF PLASTICS ENGINEERS, INC.
Thermoforming Division
 P. O. Box 90678
 Nashville, Tenn. 37209

BOARD OF DIRECTORS

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 Education
 M. James Holden, Jr. 716/394-1525

SECTION / DIVISION COORDINATOR

Mrs. Darlene F. Reed 203/775-0471
 Society of Plastics Engineers, Inc.

Officers and BOD Members

Officers of the Thermoforming Division are: Chairman: H. Osmers, Chairman-Elect: N. Zwiebel; Secretary: F. Palmer and Treasurer: M. Hibel. Executive Committee is comprised of the Officers, past Chairman (C. Hovsepian) and Councilor R. Ray. Committee Chairmen are: Technical Program: J. Throne, Publications: D. Brammer, Membership: W. McConnell, Jr., Nominating: C. Hovsepian and Education: J. Holden. Section/Division Coordinator is Mrs. Darlene Reed.

Members of Board of Directors with Terms ending ANTEC 1982

Richard A. Brammer Industrial Department School of Technology and Applied Arts Ferris State College Big Rapids, Mich. 49307	Peter I. Hughes The Hughes Plastics Co., Inc. 2501 Spring Street Redwood City, Calif. 94063
A. Richard Dobrin Electro General Plastics P.O. Box 20140 Cleveland, Ohio 44120	William F. Kent Brown Machine Co. P.O. Box 434 Beaverton, Mich. 48612
M. James Holden, Jr. Mobile Chemical Co. 100 North Street Canandaigua, NY 14424	Guilio Misitano Hanson Pattern & Mold P.O. Box 384 Ludlow, Mass. 01056
Charles Hovsepian Packaging Systems Corp. 400 Route 303 Orangeburg, NY 10969	Hubert O. Ranger Consulting Associates 10500 N. Port Washington Road Mequon, Wis. 53092

Members of Board of Directors with Terms ending ANTEC 1983

Morton A. Hibel Owens-Illinois Corporate Technology P.O. Box 1035 1700 N. Westwood Avenue Toledo, Ohio 43666	Franklin D. Palmer Aladdin Synergetics Inc. 703 Murfreesboro Road Nashville, Tenn. 37210
John T. Kelly Hopple Plastics, Inc. 7430 Empire Drive Florence, KY 41042	James L. Throne Plastic Products Division Amoco Chemicals Corp. P.O. Box 400 Naperville, Ill. 60540
William T. Loeffler Alchem Plastics P.O. Box 43248 20 Enterprise Blvd. SW Atlanta, GA 30336	Norman Zwiebel Fibracon, Inc. 55 Coldenham Road Walden, NY 12586
Herman R. Osmers Chemical Engineering Analysis 215 East Ridge Road Rochester, NY 14621	

Papers for 1983 ANTEC

We feel this is a good time for the membership to be thinking of what they would like to talk about or hear about at the 1983 ANTEC in Chicago. This should be a well attended meeting and we would like a good cross-section of papers for it. Here's how you can proceed:

1. Write up a 100-200 word abstract of your presentation. Included should be your name, address and phone number and a note that it is for Thermoforming at ANTEC 1983.
2. Send this to:
James L. Throne, TPC Chairman
Amoco Chemicals Corporation
P.O. Box 400
Naperville, Illinois 60566
3. If you finish this paper after July, send it to the Conference Manager at SPE Headquarters.
4. Get busy on the full paper, 8 pages and drawings. The deadline will probably be November 1, 1982.

Don't put this off; our division is only as successful and viable as its members, and our Technical Program is our opportunity to tell others how we are doing! See you at ANTEC '83 in Chicago!

Technical Sessions

Again this year, your Thermoforming Division will sponsor a technical session at ANTEC that promises to have something for everyone. We have six papers, scheduled for Wednesday afternoon, May 12, 1982, in the California Room of the Hilton in San Francisco. We have new materials (Cadon, Bexor), analyses of current processes, solid phase forming technology, three academic papers, three industry papers and two foreign contributions (Zagreb and IKV, Aachen). Our session starts at 2 p.m. and the final paper will be followed with our annual business meeting.

2:00 p.m. THERMOFORMING HEAT BALANCE, I. J. Catic and M. J. Sercer (Zagreb). The entire thermal cycle for thermoforming of a given shape. Particular attention has been paid to a heat balance from the heated sheet to the mold as well as heat exchange with the environment. For straight vacuum forming, the following phenomena were observed: natural and forced convection from the upper surface of the sheet and mold sides to the environment and heat conduction to the mold base plate and

Notable Speaker List Grows for 40th ANTEC

Gerald B. Mitchell of Dana Corporation in Toledo, Ohio, and Paul M. Cook of Raychem Corporation in Menlo Park, Calif., both corporate chief executive officers, are slated to address SPE's 40th Annual Technical Conference (ANTEC) in San Francisco. They join J. Peter Grace, Chairman of W. R. Grace & Company, who is also scheduled to address the plastics engineers.

Mr. Mitchell is president, chief executive officer, and chairman of Dana's Board of Directors. He will be the featured speaker at lunch on Tuesday, May 11, in the San Francisco Hilton, SPE's Conference headquarters. His topic will be the effect of big government on the economy. Mr. Mitchell is a Canadian who started as a machine operator with Hayes-Dana Limited at the age of 16 years. Dana Corporation, a producer of automotive and industrial gear and drive parts, recorded sales of \$2.75 billion in 1980.

Paul Cook is the founder and president of Raychem Corporation, a producer of plastics and metal wire and cable. Mr. Cook's topic will be "Innovations in Radiation Polymer Technology" when he addresses the first plenary meeting of the Conference on Monday, May 10. Raychem Corporation has pioneered the processing of plastics through radiation chemistry, and, in particular, the application of this innovation to the production of new wire and cable constructions and insulating materials. The most widely known of the applications is the evolution of heat shrink-ability and "elastic memory." This development is the direct result of Mr. Cook's personal leadership as a scientist, engineer, and administrator.

Mr. Grace has been Chief Executive Officer of W. R. Grace since 1945, a position he has held longer than any other chief executive of a major U.S. industrial firm. His talk will coincide with the theme of the conference, "Plastics - Meeting Challenges of the Future."

W. R. Grace is an international chemical company founded in Peru more than a century ago. Under Mr. Grace's leadership, it has grown to be one of the top 50 U.S. industrial firms and the fifth largest chemical company. Industrial chemicals represented approximately one-third of its 1980 sales of \$6.1 billion.

The San Francisco Conference marks SPE's 40th birthday. Several notable milestones will be observed during this annual meeting which recorded over 5,000 attendees last May in Boston. Part of the conference, but separate from its sessions in the Hilton, will be the largest seminar program ever sponsored by the Society. These seminars will be held in San Francisco's Sir Francis Drake Hotel. They are intensive courses on technical and management topics for professionals in the plastics industry and are taught by experts recognized as such in their field. Twenty-two seminars will run a full single day and nine others will be given over a two-day period.

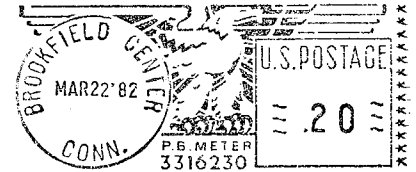
forming machine plate. We found that 86.2% of the heat transfer was through forced heat convection, 8.6% by natural convection, and 5.2% by heat conduction through the mold. All but 3% of the heat received by the sheet during IR heating was accounted for. The difference in calculated and measured contact temperature of the sheet in the mold was 1.6 to 3.3%.

2:30 p.m. INFRARED HEATING CHARACTERISTICS OF PIGMENTED POLYETHYLENE TEREPHTHALATE WEBS, W. J. Hennessey and R. R. Kraybill (Eastman Kodak). The effects of low concentrations (1 to 2% by weight) of carbon and titanium oxide pigments in polyethylene terephthalate are reported for absorbance, transmittance and reflectance as a function of quartz infrared heater temperature. Similar results are presented for three different thicknesses of carbon pigmented resin. A continuous loop of web was passed at 65 fpm over a Solar quartz model C infrared heater. Incident and transmitted heat fluxes were measured with a heat flux transducer. Absorbed energy flux was calculated from a heat balance obtained by measuring inlet and outlet sheet temperatures with an infrared thermometer. The results are compared with the Bouguer-Lambert absorption law and Fresnel's equation for reflectivity. Results of electrical heating efficiency are interpreted by comparison of the infrared absorption spectra of the webs and Planck's radiant energy distribution equation.

3:00 p.m. THERMOFORMING CADON ENGINEERING THERMO-maleic anhydride terpolymers was announced by Monsanto in May 1981. We have assessed the potential for Cadon in sheet extrusion/thermoforming applications. A preliminary trial in an May 1981. We have assessed the potential for Cadon on sheet extrusion/thermoforming applications. A preliminary trial in an experimental thermoformed wheelcover showed promise in that good material distribution in this moderate draw application was easily achievable. We then developed a candidate extrusion/thermoforming grade of Cadon that would possess the desired level of gloss, toughness, chemical resistance and most important ease of processability. Once these parameters were fixed, we assessed the thermoforming characteristics of the product vs. well known extrusion grade engineering thermoplastics, high heat ABS and standard ABS grades. Particular attention was paid to inherent hot strength of the polymers under consideration, material distribution as a function of draw, temperature and plug assist, as well as cycle time. These studies were done using in-house laboratory and commercial size extrusion equipment to prepare the sheet stock. An Illig RDKM high speed thermoformer was used for the deep draw studies and a single stage Autovac machine for the heavier gage shallow draw work.

3:30 p.m. BEXOR POLYPROPYLENE - SUPERTOUGH THERMOFORMABLE BIAXIALLY ORIENTED SHEET, A. R. Austen, D. V. Humphries (Bethlehem Steel) and C. L. Fay (Kusan). BeXor is a trademark of Kusan, Inc. for a biaxially oriented, heavy-gage polypropylene sheet with dramatically improved thermoformability. BeXor is produced by a novel solid-state hydrostatic extrusion process. Mechanical and physical properties were determined on 24-inch square BeXor sheets 0.06 to 0.19-inch thick with biaxial orientation ratios up to 2.5X. The tensile strength of BeXor polypropylene is two to three times greater than that of unoriented polypropylene sheet. Its toughness is up to ten times greater even at temperatures down to -50F (-46C). The strain hardening characteristic imparted to the new sheet by biaxial orientation results in excellent material distribution, thickness control and surface detail in complex deep-drawn thermoformed parts. In general, the mechanical property improvements due to biaxial orientation in the case of BeXor polypropylene are also achievable in other semicrystalline thermoplastics such as BeXor polyethylene, polyacetal, polyamide and thermoplastic polyester. In addition to reporting on the mechanical and physical properties of BeXor polypropylene, this paper describes the thermoforming of the material using vacuum, air pressure and stamping and also lists areas of potential application for formed parts.

Continued



Technical Sessions *Continued*

4:00 p.m. INFLUENCE OF THERMOFORMING PARAMETERS ON THE PROPERTIES OF THERMOFORMED PP, H. Gross, G. Menges (IKV). The influence of thermoforming parameters on the properties of formed PP is determined from precise knowledge of the structure of the starting film. With this knowledge, it is possible to establish the structural changes that occur during individual phases of thermoforming and thus to build up the final structure by stringing together the sequence of individual changes. The chief parameters that cause modification in the polyethylene superstructure, and hence in its crystallinity and in the structure and size of the spherulites, are the heating process, the stretching process and the cooling process. The most important process parameter is film temperature at the time of forming. For the PP homopolymer formed into simple cups, forming temperatures were varied between 145 and 165C (measured film surface temperature). At the end of the heating phase, large, hexagonal beta-spherulites are present, distributed uniformly over the test piece. With thermoforming at 165C, these structures have already been totally melted open. During the stretching process, the beta-spherulites extend into long pits on REM plates. This produces formed parts with very rough surfaces and very poor transparency. In the case of lower forming temperatures, in particular, the structural re-arrangement causes a reduction in material density, as compared with the initial density, in those areas that undergo pronounced stretching. Increased forming temperatures bring improvements in formed part transparency, forming accuracy and thermal stability. Apart from forming temperature, the effects of different mold and plug temperatures on molding quality were also investigated.

4:30 p.m. PREDICTION OF STRAIN RECOVERY DURING SOLID-PHASE FORMING OF THERMOPLASTICS, R. K. Okin (duPont) and N. P. Suh (MIT). Forming of thermoplastic materials in the solid phase is generally accompanied by some recovery or springback in the deformed material on removing the forming load. An approach is presented in this paper to predict such strain recovery behavior for polycarbonate (PC) and high impact polystyrene (HIPS) under both isothermal and non-isothermal conditions and large strain levels. Isothermal creep and stress relaxation tests were run and the resultant plots fitted with a power law relationship. This was done for both compressive and tensile loading for PC and only tensile for HIPS, all above T_g. It was found that the pre-power law coefficient was approximately linearly related to either the initial strain or to the initial stress in the respective stress relaxation or creep tests at a given temperature. This was true, especially at high temperatures and low strain levels. An expression for the strain recovery after release of the load required for an initial step strain was derived based on linear viscoelastic theory. The results show reasonable correlation with experimental recovery data. The constants of the power law relationship were then determined over the temperature range of 150 to 190C. Master curves and the resultant shift factors, obtained by superposing the stress relaxation and creep data (both in tension and compression, for PC only), were

used with the time-temperature superposition principle to numerically evaluate uniaxial strain recovery under a specific temperature history. The average temperature history obtained by numerically solving for the temperature distribution in a disc, at an initially high temperature and in contact with a cold metal surface was used. The theoretical results were compared with recovery data obtained from non-isothermal backward extrusion tests with a temperature history similar to the model. Reasonably good agreement was obtained.

SPE '82 Conference Calendar

The Society of Plastics Engineers (SPE) has released a schedule of Technical Conferences for 1982. This schedule contains a list of conferences to be held in the months of May through November, 1982. The Society's 40th Annual Technical Conference in May is among the meetings listed and will offer an expanded seminar program in San Francisco.

SPE's 1982 Technical Conferences

May 10 - 13 — "Plastics - Meeting Challenges of the Future," 40th Annual Technical Conference and Exhibition sponsored by the Society of Plastics Engineers: Hilton Hotel, San Francisco, California. Contact: Nancy J. Rein, Conference Manager, Society of Plastics Engineers, Inc., 14 Fairfield Drive, Brookfield Center, CT 06805. Tel. (203) 775-0471.

May 26 - 28 — "PVC, A Classic Material, A Product for the Future," European Travel Conference sponsored by SPE's France Section: Sophia-Antipolis, Nice Airport, France. Contact: Rene Bedier, Secretary, SPE France, 65 Rue de Prony, F75854 Paris Cedex 17, France.

June 21 - 23 — "EMI/RFI Electrical Shielding," Regional Technical Conference sponsored by SPE's Chicago Section and Electrical and Electronics Division: Sheraton O'Hare Hotel, Rosemont, Illinois. Contact: Harold Chapman, DME Company, 1975 North 17th Avenue, Melrose Park, IL 60160. Tel. (312) 626-2900.

October 5 - 6 — "Colorant Behavior in Polymer Systems," Regional Technical Conference sponsored by SPE's Palisades Section and Color and Appearance Division: Playboy Resort Country Club at Great Gorge, McAfee, New Jersey. Contact: Stanley J. Anton, Anton Chemicals, Inc., 331 Cyphers Lane, Midland Park, NJ 07432. Tel. (201) 652-0546.

October 19 - 20 — "Processing and Finishing of Plastics in Small Business Equipment and Machine Parts," Regional Technical Conference sponsored by SPE's Rochester Section: Genesee Plaza Holiday Inn, Rochester, New York. Contact: Fred Buja, Eastman Kodak Company, 901 Elm Grove Road, D-45 B-4, Rochester, NY 14650. Tel. (716) 726-3134.

October 25 - 27 — "The Plastics ABC's: Polymer Alloys, Blends & Composites," National Technical Conference sponsored by the Society of Plastics Engineers: Sheraton Bal Harbour Hotel, Bal Harbour, FL. Contact: Nancy J. Rein, Conference Manager, Society of Plastics Engineers, Inc., 14 Fairfield Drive, Brookfield Center, CT 06805. Tel. (203) 775-0471.

November 8 - 10 — "Photopolymers: Principles, Processes and Materials," Regional Technical Conference sponsored by SPE's Mid-Hudson Section: Nevelle Country Club, Ellenville, New York. Contact: Dr. Maung S. Htoo, IBM Corporation, Box 390, D/C 30-B/701, Poughkeepsie, NY 12602. Tel. (914) 463-1331.

November 10 - 12 — "Polyimides I," Regional Technical Conference sponsored by SPE's Mid-Hudson Section: Nevelle Country Club, Ellenville, New York. Contact: Julius M. Schiller, IBM Corporation, C/A44-B/052, Poughkeepsie, NY 12602. Tel. (914) 463-6777.