

# NEWSLETTER



## THERMOFORMING division

SOCIETY OF PLASTICS ENGINEERS, INC.

### Chairman's Comments

We now have an ongoing Division with a full slate of officers, directors and committees. With this second Newsletter, we have an established mechanism to keep our members informed of Division activities. Our membership is at about 700, and there is every indication that this will grow because of an active membership campaign by the Membership Committee. We will have an excellent technical program at the San Francisco ANTEC in May, and plans are well underway for another session (or two) at the 1983 ANTEC in Chicago. We are developing an advanced thermoforming seminar, a slide/film presentation on thermoforming, and a thermoforming brochure, all of which can be expected to help the development of our profession.



Dick Osmers

This was made possible by the dedication and hard work of many people, and I would be remiss in not recognizing their contributions. I understand that, in so doing, I likely will omit recognition of equally deserving people, but I hope that they will understand that the omission was by oversight and that their contributions were nonetheless appreciated. Mort Hibbel, as Treasurer, has brought the Division's finances into line and up to date, while Frank Palmer, as Secretary, has maintained all the necessary correspondence and minutes and has made many of the arrangements for Division meetings. Pete Hughes has been actively involved as the recently elected Chairman-elect, and has plans well underway for his tenure as Chairman. Dick Brammer has gotten these Newsletters out in a timely and excellent manner. Jim Throne is largely responsible for the high quality of the Technical Program at ANTEC. Charlie Hovsepian has seen to our nominating needs, and has provided the artwork for our Newsletter. Bob Ray has maintained our coordination with SPE by participation in Council meetings. Bill McConnell, Pete Hughes and John Wise have rejuvenated our membership activities. We have had tremendous support from SPE by virtue of extensive interaction with Dee Reed who knows so well how to get things done. And, of course, the entire Board has been tremendously useful at all times. It has been my pleasure and good fortune to have had the opportunity to work with these and many other people. At the conclusion of the 1982 ANTEC, the new officers will take over the direction of the Division, and I have every confidence in

their ability and dedication to increase the momentum of the Division.

In thinking about the latter, several recent conversations come to mind. It is clear that thermoforming has an established role in certain areas such as packaging. But it does not appear that an expanded role is widely accepted, by that meaning the ability to generate parts at high volumes to very close tolerances that are now made by other processes such as injection molding. We should expect to maintain the position of thermoforming in certain areas, but we should also expand our horizons to other areas as well for we certainly can make major contributions in quality and costs of parts and savings of materials. If we are at all successful in that - and I am certain that we can be - then we will have served our Division, our profession and ourselves quite well. I look forward to the fruits of our labors.

### Thermoformer of The Year Award

William K. McConnell Jr., President of McConnell Company of Fort Worth, Texas, is scheduled to receive the first annual Thermoformer of the Year Award at the Thermoforming business meeting at ANTEC on May 12, 1982.

Mr. McConnell is a noted lecturer and consultant on all phases of thermoforming and has held various local and national offices in SPE and SPI. He has worked tirelessly to develop curricula for vocational training programs in every level of education and has advanced thermoforming training to an unparalleled state. Mr. McConnell exemplifies to the letter the ideal recipient of the Thermoformer of the Year Award.

### Business Meeting

There will be a business meeting for Thermoforming members after their technical program on Wednesday, May 12 at ANTEC for about 1/2 hour and this will include the award of the Thermoformer of the Year Award to Bill McConnell.

### Board Meeting

The next Board of Directors meeting is scheduled for Wednesday, May 12 from 7 to 11 a.m. at the San Francisco ANTEC.

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

**BOARD OF DIRECTORS**

- Richard A. Brammer .....616/796-0461..... 1982  
School of Technology and Applied Arts  
A. Richard Dobrin .....216/231-8585..... 1982  
Electro General Plastics  
M. James Holden, Jr. ....716/394-1525..... 1982  
Mobil Chemical Co.  
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Hanson Pattern & Mold  
Hubert O. Ranger .....414/241-8100..... 1982  
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Owens-Illinois Inc.  
John T. Kelly .....606/283-1570..... 1983  
Hopple Plastics, Inc.  
William T. Loeffler .....404/696-4280..... 1983  
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Chemical Engineering Analysis  
Franklin D. Palmer .....800/251-1065..... 1983  
Aladdin Synergetics Inc.  
James L. Throne .....312/420-5111..... 1983  
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Dr. Richard R. Kraybill .....716/477-4271..... 1984  
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New England Plastics, Inc.  
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AAA Plastic Equipment, Inc.

**DIVISION OFFICERS**

- Chairman .....Herman R. Osmer  
Chairman-Elect.....Peter I. Hughes  
Secretary .....Franklin D. Palmer  
Treasurer .....Morton A. Hibel  
National Councilman.....Robert W. Ray  
Past Chairman .....Charles J. Hovsepian

**COMMITTEE CHAIRPERSONS**

- Technical Program .....James L. Throne  
Publications .....Richard A. Brammer  
Membership .....William K. McConnell, Jr.  
Nominating .....Charles J. Hovsepian  
Education .....M. James Holden, Jr.  
Standards .....Peter I. Hughes  
S.P.E. Coordinator .....John T. Kelly  
Public Information.....M. James Holden, Jr.  
Auditing .....Morton A. Hibel  
Election Audit.....William F. Kent  
Awards .....James L. Throne

**SECTION / DIVISION COORDINATOR**

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

**Addresses of Board Members**

Addresses of the Members of the Board of Directors are given for your convenience in case you have any correspondence.

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  
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Hubert O. Ranger  
Consulting Associates  
10500 N. Port Washington Road  
Mequon, Wis. 53092

Members of Board of Directors with Terms ending ANTEC 1983

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Owens-Illinois Corporate Technology  
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Chemical Engineering Analysis  
215 East Ridge Road  
Rochester, NY 14621

John T. Kelly  
Hopple Plastics, Inc.  
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Florence, KY 41042

Franklin D. Palmer  
Aladdin Synergetics Inc.  
703 Murfreesboro Road  
Nashville, Tenn. 37210

William T. Loeffler  
Alchem Plastics  
P.O. Box 43248  
20 Enterprise Blvd. SW  
Atlanta, GA 30336

James L. Throne  
Plastic Products Division  
Amoco Chemicals Corp.  
P.O. Box 400  
Naperville, Ill. 60540

Members of BOD with Terms ending ANTEC 1984

Lester C. Bohannon  
Beech Aircraft Corp.  
Airport Industrial Center  
Salina, KS 67401

James B. Osborne  
New England Plastics, Inc.  
126 Duchaine Blvd.  
New Bedford, MA 02745

Richard R. Kraybill  
Manufacturing Technology Division  
Kodak Park, B-35  
Rochester, NY 14650

Stanley R. Rosen  
Thermoform Machinery Corp.  
167 Western Highway  
West Nyack, NY 10994

John R. Wise  
AAA Plastics Equipment, Inc.  
2617 N. Ayers  
Fort Worth, TX 76103

**1983 ANTEC Papers**

Have you been thinking of a topic for a paper you could write for the 1983 ANTEC in Chicago? We introduced this in our last Newsletter and would like to have you turn in your abstract in the near future. Here is how to 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:  
H. R. Osmer  
Chemical Engineering Analysis  
215 East Ridge Road  
Rochester, NY 14621
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 be probably by November 1, 1982.

Don't delay, get busy now! Remember, this is an opportunity to tell others how Thermoformers are doing.

# 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

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 absorptance, 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 THERMOPLASTICS, W. J. Hall, M. A. Cannon, (Monsanto). A new family of engineering thermoplastics based on impact modified styrene 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 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.

## Highlights of March

### BOD Meeting

Thermoforming Board of Directors held their last meeting at the Host International Hotel in Detroit, Michigan on March 6, 1982. Highlights of the meeting include:

1. The Thermoforming Division has supported the production of the 16mm film by SPE with a contribution of \$500.
2. An advanced Thermoforming Seminar is being developed with the intent of its being available at the 1983 ANTEC.
3. We will have a technical program at the San Francisco ANTEC on Wednesday, May 12 with six papers.
4. The balance in our division treasury is \$4,565.28.
5. The first newsletter has been distributed to the membership and the second should be distributed prior to the ANTEC in May.
6. The election of new members of the Board of Directors for the class of 1985 should be completed by the May ANTEC, and Frank Palmer has been nominated for Counselor for the 1982/83 year.
7. Bill McConnell was selected as the recipient of the first Thermoformer of the Year Award, to be presented at the May 12 business meeting.
8. New Division officers were elected for 1982/83; Pete Hughes, Chairman; Charlie Hovsepian, Chairman-elect; John Wise, Secretary; Mort Hibel, Treasurer.
9. We are working on the development of a slide/film presentation on thermoforming, and a brochure on thermoforming to be distributed to the membership and prospective membership.

## 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.



## 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. Okine (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 Tg. 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 evaluated 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.

## TVC Needs Our Input

Jim Throne, Chairman, Technical Volumes Committee, has told us of a revitalization project his committee has undertaken this year. Remember the paperback series that SPE underwrote a few years back? Well, Jim tell us that new titles are being added all the time. (For example, he says that sometime in 1982 we should look for an important source book of thermo-plastic structural foam.) But, the TVC wants to do more in this area.

They want new titles and authors in areas such as RIM molding, thermoset processing, thermoforming, microprocessors and processing, decorating plastics, joining plastics, and so on. This material is to be basic, without equations and theory and is to be aimed at the process equipment operator, the lab technician, the manager, the purchasing agent. The published books will normally run 100 6x9 pages on glossy paper. The authors will receive a one-time royalty payment.

This concept sounds good to us. The goal of writing for the worker rather than the researcher appeals to us and the soft cover concept keeps the cost down. We fully support TVC's concept and urge each one of you to consider putting the practical stuff of your processes on paper. Why not write to Jim Throne, Amoco Chemicals Corp., P.O. Box 400, Naperville, IL 60566 and give him a title and brief outline of your book. Jim has promised that his committee will work with you on your project.