

TPM&F

Thermoplastic Materials & Foams



A divisional newsletter of the Society of Plastics Engineers

Volume 1, 2011/2012

Communication Excellence Award

TPM&F SCOPE

The Thermoplastic Materials and Foams Division is organized to provide a focal point for the interchange of information relating to non-vinyl thermoplastic resins including fluoropolymers, polyamides, polyesters, polyolefins, polystyrenes, polyurethanes, their filled and/or reinforced products, and their foamable and foamed products. Its interests lie in stimulating the development of scientific and engineering knowledge. By encouraging participation between producers and consumers, it aims to provide information on new developments which shall encompass synthesis, characterization, fabrication, safe handling, application, serviceability, and marketing.

Pinnacle Award

2011 Winner



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CHAIRMAN'S MESSAGE



As the new Chairman of the TPM&F Division I am honored to write my first message. I want to thank all of the volunteers at SPE and our Division members who allow us to function as a successful organization. Remember, our purpose is to serve you, our members and valued customers that work or have interests in the plastics industry. We want to hear from you.

Our Division hosted FOAMS® 2011 TopCon from September 14-15 at Renaissance Woodbridge Hotel in Iselin, NJ. This conference was co-sponsored with the Palisades New Jersey Section. The conference was well attended and the quality of the papers was great. I would like to recognize the following Board members Sal Monte (*Conference Chairman*), Miguel Rodriguez-Perez, Max Wingert and Theresa Healy who have put tremendous efforts in planning and organizing this successful event. I also want to recognize the excellent support we received from Richard Bradley (*Co-Chairman*) and his team from the Palisades-NJ Section.

Prior to this conference, Foams Tutorial was conducted by Chul Park, Hani Naguib and S. T. Lee on September 12-13. They did a great job in teaching this course. Please review the report on FOAMS® 2011 prepared by Sal Monte and his team in this issue.

Dale Grove, Best Paper Chairman, and his team did a great job in prescreening and further reviewing selected papers at the conference to identify one best paper from the conference. I would like to thank Dale and his team for the great work. Also congratulations to the authors of the best paper -- Jana Dlouha and Hiroyuki Yano of the Kyoto University. To read the paper and abstract please refer to pages 6-10 in this issue.

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The first new objective of the Division is to host Foams TopCon outside North America in 2012. This is to reach out to our members in other regions. After consulting with the SPE Headquarters and reviewing with the Board members, I am pleased to inform that the Board has approved FOAMS® 2012 in Barcelona, Spain. The planned dates are September 10 - 13. We are fortunate to have a Board member, Miguel Rodriguez-Perez, based in Barcelona has graciously agreed to Chairing this conference. We will communicate more information with the members as soon as it is available. Please mark your calendar and make plans to attend this conference next year.

The TPM&F Division will sponsor two technical sessions at the International Polyolefins Conference & FlexPackCon to be held in Houston, TX February 27-29, 2012. I would like to thank Andy Chatterjee and Donna Davis for compiling the program for these sessions. There will be more updates on the SPE's website once the entire conference program and schedule are finalized.

Our Division plans to organize several sessions at ANTEC® 2012 that will be held April 2-4, 2012 in Orlando, FL. The Technical Program Chairperson is Donna Davis. She is still soliciting technical papers. If you would like to present a paper, please get in touch with Donna.

The second objective for the coming year is to establish a website for the TPM&F Division. The website will significantly improve the way we communicate with our members. Our Communication Chairperson, Theresa Healy, is already working on this initiative and plans to have a website established by the end of the year. Please feel free to contact Theresa if there are suggestions or certain features you would like to see on the website.

Continued on page 3



April 2-4
Orange County Convention Center
Orlando, Florida USA

CALL FOR PAPERS

Troubleshooting—Innovation—Cost Reduction
PAPER DEADLINE
October 19, 2011

The SPE Thermoplastic Materials & Foams Division is calling for papers for ANTEC® 2012 in Orlando. Sessions will feature recent research and development in

Foams Polyolefins Engineering Thermoplastics

Papers reporting either fundamentals or applications are invited, theoretical or commercialized.

Please submit papers at and select TPM&F as the preferred Division.

Paper submissions Deadline: October 19, 2011

[click here](#)
CALL FOR PAPERS

Visit the Thermoplastic Materials & Foams Division webpage.
Division 29

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I am pleased to inform the Division finances are healthy despite the tough global economy. Thanks to the efforts of our current treasurer, Max Wingert and former treasurer Wen Wu, who retired from the Board earlier this year.

Hani Naguib, Education Chairman, is planning to organize and co-sponsor a new webinar series in 2012 with the SPE Headquarter. Please feel free to contact him if there is a topic you would like to cover in the webinar series. Please share your thoughts on any student activities you would like our Division to sponsor.

The third objective of the Division is to aim for the 'Notable Achiever Award' in the coming year. This will require good support and dedication from the entire Board. Thanks to Xiaoxi Wang, Newsletter Chairman, for making this suggestion.

The TPM&F Board of Directors meeting was held on September 13, 2011 during Foams 2011 Conference. The minutes of the meeting are included in this newsletter. The next meeting will be held on February 27 in Houston during the Polyolefins 2012 Conference. The meeting is open to all the members and may be attended in person or by teleconference. We would like to hear thoughts and new ideas from our members.

Again, let us work together to accomplish the Division objectives in serving our members, fellow SPE professionals, scholarship/student chapter and community outreach. Should you need further information or have an idea or feedback, please do not hesitate to contact us.

Kind regards,

Perry Vadhar
Chairman,
Thermoplastics and Foams Division
perry.vadhar@sealedair.com

Meet your Board of Directors



Hani Naguib is an Associate Professor at the University of Toronto and holder of a Canada Research Chair in Smart and Functional Materials. He is appointed in the department of Mechanical and Industrial Engineering and cross appointed in the department of Materials Science and Engineering and Institute of Biomaterials and Biomedical Engineering. He got his Ph. D in Mechanical Engineering from the University of Toronto in 2001. Thereafter, he spent one year as an NSERC Postdoctoral Fellow at the University of Toronto in 2002 and three years as an Assistant Professor at the University of Ottawa till 2005. His major expertise is in the area of smart and adaptive polymer systems including active polymers; biopolymers; nano and porous polymers. He has many refereed publications and scholarly addresses to date in the field. He is the recipient of numerous honours and awards such as the Canada Research Chair, the Premier's Early Research Award of Ontario, the Canada Foundation of Innovation, and the faculty Early Teaching Award. Hani is a Professional Engineer in Canada, a Chartered Engineer in U.K., a Fellow of the Institute of Materials Minerals and Mining IOM3 in UK and Fellow of the Canadian Society of Mechanical Engineers, with other professional engineering affiliations. He has been serving as member on the technical divisions board for the Society of Plastics Engineers SPE, the American Society of Mechanical Engineers ASME, the Materials Information Society ASM, and the Canadian Society of Mechanical Engineers CSME. He has been organizing and chairing many symposia, technical programs and sessions in ASME, SPE, SPIE, PPS, CSME, CMSC, CIMTEC and Biofoams conferences. He is actively involved in collaborative research projects with academic institutions, hospitals and industrial partners in Canada and worldwide.



Masahiro Ohshima has been serving as a Professor of Chemical Engineering at Kyoto University and the Leader of Material Process Engineering laboratory. From the beginning of his academic career, he has devoted himself to researches in both the process control and polymer processing. His main achievement in process control area was to invent disturbance prediction model predictive control and derive a theory of multirate-multivariable predictive control. He was recognized with the Control Practice Engineering Prize in 2002 from the International Federation of Automatic Control. In the polymer processing area, he proposed nanocellular foam concept to produce superior function to conventional porous materials. He obtained the Best Paper Award from the Thermoplastic Materials and Foams Division of the Society of Polymer Engineers, three times, 2002, 2004 and 2007, Best Research Achievement Award from the Society of Chemical Engineering, Japan, and Best Technology Awards of 2011 from the Japanese Society of Polymer Processing. He has been conducting joint university-industry research projects with many companies as well as governmental projects.

Nominating Chair's Report

Michael Reedy has resigned from the board. We should update that in our BOD list. We have 7 board members for the 2014 board with the addition of Xiaoxi Wang and Neil Witten. We currently have 21 BOD members and we have a full board. We have 2 potential members (*they were on the last election ballot but were not elected*) that can be added to the board as any opening occurs. Our terms of office are from July 1 through June 30, for a 3-year term. The next election, will be for the 2012 BOD and will be conducted during March-April 2012.

— Ray Shute



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TPM&F Newsletter/Communication Chair Report

4 issues of newsletters are planned for the 2011/2012 fiscal year:

- ▶ October 2011 (*after FOAMS TopCon*)
- ▶ Late January/Early February 2012 (*before PO TopCon*)
- ▶ Early March 2012 (*after PO TopCon; before ANTEC*)
- ▶ Early May 2012 (*after ANTEC; before FOAMS TopCon*)

Focuses are:

FOAMS[®] Conference: 09/12- 09/15/2011

Polyolefins Conference: 02/26-02/29/2012

ANTEC 2012: 04/02- 04/04/2012

BOD meetings

SPE Council meeting

Advertisements

Sponsorship size allocations (*1 year, 4 issues*):

- ▶ BC size: 3.500" wide x 2" high \$500
- ▶ 1/4 page size: 3.875" wide x 5" high \$900
- ▶ 1/2 page size: 7.750" wide x 5" high \$1,500

Note: We do not have anyone actively soliciting the sponsorship for newsletters. It may be fine since the financial status of TPM&F is in a good shape.

Pinnacle award requirements (*application deadline 11/30/2011*),

- ▶ Newsletter (*at least 2 issues*)
- ▶ Website
- ▶ Innovative communication tools (*LinkedIn*)
- ▶ Generational Reach in Communication (*public outreach programs etc.*)
- ▶ Successful Use of Two-Way Modes of Communication Best Practices
- ▶ Branding and Communications Guidelines

There are three levels of awards showing below. We won "Special Recognition" for the last fiscal year. We should aim for "Notable Achiever" this year. The requirements are:

- ▶ Communications Leader: full range of achievements
- ▶ Notable Achiever: excel in 1 or 2 areas
- ▶ Special Recognition: achievement or differentiated performance at the discretion of the review committee

– **Xiaoxi Wang**

Communication Chair Report

Communication: We need to work closely with Xiaoxi Wang on anything we want to communicate to our members. Information should be given to Xiaoxi for our newsletters. We should also work closely with the editors on highlights for the various conferences so these can be included in our newsletters, Linked In site, and the development of a website. My suggestion is to put together a Communication Committee to help work as a team on some of these projects so that our division can continue to gain "Special Recognition" or strive for "Notable Achiever" in the coming years.

Linked In TPM&F site: We currently have 218 members. I have put the information about the FOAMS[®] conference on the site. If anyone has upcoming conferences they would like uploaded on the site, please send the information to me and I will upload it on the Linked-In site. We need to utilize this site for keeping our members informed about anything related to the TPM&F. Any suggestions would be welcome to bring additional value to the site.

SPE Site: The SPE site also has been advertising the TPM&F conferences for us. An example would be the recent FOAMS[®] conference where they have provided detailed information along with the uploaded sponsors. I think this is a very helpful tool for promoting these events.

– **Theresa Healy**

Welcome New Members!

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Mosha Zhao	ExxonMobil Chemical Company
Kam-Sing Cheung	ExxonMobil Chemical Company
Youn Won Jeong	Kumho Polychem
Akos Kmetty	BME Polimerteknika Tsz
Jeffrey Johnson	Aquafil USA
Nicholas Melfi	3M Attenti R & D
Shaun Gaus	Bayer MaterialScience LLC

– **Camino Cano**

Polyolefins 2012 International Conference Report

For PO 2012 Conference (to be held in Houston during February 27-29, 2012) TPM&F Division is organizing two technical sessions as a partner in the PO conference. Good progress is being made on both sessions.

Donna Davis is developing a session on “Polyolefins in Rigid Packaging”. Papers from American Chemistry Council and McConnell Company have been committed. Donna also has solicited papers from seven other companies. This session will be held on February 28 (Tuesday) in the morning.

Ananda Chatterjee is organizing a session on “Advancements in Polyolefin Foams”. He has received commitments from six speakers, namely from Dow Chemical, JSP (Japan), Simona (Germany), Kyoto University (Japan), E-Beam Services and Coperion. This session will be held on February 28, 2012 PM. Abstract, Author's Release etc have been submitted by several speakers. The written paper is due by November 15, 2011 and the final Presentation is due by December 15, 2011.

— Ananda Chatterjee

FOAMS® 2012 will be held in
Barcelona, Spain
from September 10 - 13, 2012.



Best Paper FOAMS® 2011 CONFERENCE

Foaming of Hydrophilic Polymers Using Supercritical CO₂

by Jana Dlouhá and Hiroyuki Yano, from Laboratory of Active Bio-based materials, Research Institute for Sustainable Humanosphere, Kyoto University

Abstract

In view of supercritical foaming of cellulose nanocomposites, the foamability of hydrophilic polymers readily compatible with cellulose nanofibres (CNF) without the need of chemical modification was studied. Polyvinyl alcohol (PVA) and hydroxypropyl cellulose (HPC) were selected as examples of hydrophilic polymers. The goal of the study was to investigate the effect of foaming conditions such as foaming temperature, plasticizer content and surface confinement of the film on the foam morphology. Use of plasticizer revealed to be necessary to foam PVA below 160°C (*limiting temperature for processing of cellulose nanocomposites*). Film containing 40phr of glycerol blown at 120°C displayed similar morphology as neat PVA foamed at 170°C. Higher amounts of plasticizer led to increase in the cell size and overall porosity that was not possible to achieve with neat PVA. Further, foaming of wet PVA films was investigated. It was found that moisture acted as very efficient temporary plasticizer giving, at lower foaming temperature, comparable foam morphology as obtained for glycerol plasticized films. HPC films could be foamed at temperatures ranging from 35°C without the use of plasticizer. Cell size together with foam porosity could be tailored by changing the foaming pressure.

Paper follows on pages 7-10.

— Del Grove



FOAMING OF HYDROPHILIC POLYMERS USING SUPERCRITICAL CO₂

Jana Dlouhá, Laboratory of Active Bio-based materials, Research Institute for Sustainable Humanosphere, Kyoto University

Hiroyuki Yano, Laboratory of Active Bio-based materials, Research Institute for Sustainable Humanosphere, Kyoto University



Introduction

Foaming of polymers with supercritical CO₂ has recently drawn a great deal of attention in the scientific community because it allows for processing of microcellular foams with tunable morphology [1, 2]. Moreover, blowing of polymers with CO₂ can be classified as “green” processing procedure [3]. Foaming process can be summarized in four steps: polymer is first saturated by supercritical gas, after stabilization the nucleation of gaseous phase is triggered by rapid depressurization or temperature increase followed by cell growth and fixation of the foam morphology by stiffening of the polymer or depletion of the gas. Nucleation rate is mainly determined by processing parameters such as foaming temperature and pressure; depressurization rate and surface tension of the polymer while the cell growth is governed by rheological properties of the polymer melt together with the diffusivity rate of CO₂. To obtain high

density cell foams, use of low foaming temperature, high pressure and high depressurization rate is preferred [4, 5].

In order to manipulate the foam morphology beyond the limits fixed by the solubility and diffusivity of CO₂ in the polymer and its molecular structure, more sophisticated approaches have to be used such as foaming of polymer blends or use of nanoparticles. In the first approach, differences in CO₂ solubility and diffusivity together with the degree of mixing of both polymers will tailor the morphology of the foam [6] while the second approach consists of using the surface of nanoparticles to speed up the nucleation process [7]. Small amount of uniformly dispersed nanoparticles may indeed represent heterogeneous nucleating sites with lower energy barrier. Increase in nucleation rate results in larger population of cells nucleated simultaneously. Reduction of the cell size and processing of high density cell foams is then possible.

Numerous reports exist in the literature about the potential of nanoparticles to act as a nucleating agent however experimentally only few percents of this potential are in general realized [8]. Nucleating efficiency of nanoparticles can be affected by several parameters such as their aggregation reducing the availability of nucleating sites and/or their relative energetic inefficiency due to strong interactions between the matrix and nanoparticle. Optimal level of interactions between the matrix and nanoparticles has to be found to obtain uniform dispersion of nanoparticles in the polymer while keeping their nucleating ability. Besides their nucleating role, nanoparticles can also hinder the cell growth by creating a physical barrier to diffusion of CO₂ as observed for platelet like clay nanoparticles [9] or affect the cell growth through the change of rheological properties of the melt [10].

So far nucleating potential of clay nanoparticles, carbon nanofibres and carbon nanotubes was investigated. In our laboratory, we would like to test the potential of cellulose nanofibres to manipulate the foaming process and affect the properties of the foam. Cellulose nanofibres are renewable and biocompatible, lightweight and exhibit good mechanical performances. Moreover, they are able to form networks maintained by hydrogen bonds even at high temperatures and thus substantially affect rheological properties of the composite in softened/molten state.

Studies on supercritical foaming of polymers in general focus on hydrophobic polymers such as polystyrene or poly(methyl methacrylate). However cellulose nanofibres are hydrophilic and it is difficult to disperse them uniformly in hydrophobic polymers without chemical modification. In this study, we want to investigate the foamability of hydrophilic polymers readily compatible with cellulose nanofibres such as polyvinyl alcohol and hydroxypropyl cellulose. Polyvinyl alcohol is known for its good mechanical and barrier properties and processing of membranes by supercritical CO₂ assisted phase inversion method was already reported [11]. Although hydrophilic, HPC is relatively hydrophobic compared to PVA and therefore less interaction with cellulose nanofibres are expected. Morphology of obtained foams is presented and effect of processing conditions is discussed.

Materials and methods

Materials. PVA and HPC were used as examples of hydrophilic polymers. Several types of low viscosity PVA donated by Nippon Gohsei were used for the study: 99.3% hydrolyzed fully amorphous PVA (T_g = 75°C; T_m = 189°C) and semi-crystalline PVA with degree of hydrolysis of 87.5%, 80.5% and 72.5% having T_m of 189°C, 182°C and 178°C respectively; T_g being around 69°C for all types. Residual PVAc content can be interesting to enhance the solubility of CO₂ in PVA [12] and can also change the strength of interaction with cellulose nanofibres [13]. DP of PVA samples was around 500 and crystallinity ranged from 37 to 14.7% depending of the hydrolysis degree. HPC with a molecular substitution of 3.4–4.4 and a weight-average molecular weight of 100,000 was purchased from Sigma–Aldrich. Glycerol, also purchased from the Sigma Aldrich, was used as a plasticizer.

Preparation of films. Films were prepared by solution casting method. PVA powder was dissolved in distilled water under mechanical stirring at temperature corresponding to its hydrolysis degree and mixed during 30min. Then, glycerol was added to the solution and stirred for another 10 min. After cooling to 60°C, the solution was cast in a Teflon mold and placed in a regulated chamber (23°C; 50RH) to evaporate water. In the case of HPC films, desired amount of powder was at first dispersed in small volume of deionized water heated at 60°C. Afterwards, hot slurry was diluted with cold water and agitation was continued at room temperature until all particles were dissolved and solution was casted in a Teflon Petri dish for evaporation. Films were demolded after approximately 72hours and were 100-200 μm thick. Before foaming, films were dried in oven at 50°C. Films for foaming with moisture as a plasticizer were stabilized in regulated chamber (RH 80%, T = 23°C)

for two days prior to foaming resulting in moisture content of 18% in the case of amorphous PVA and cca 14% in the case of semi-crystalline PVA. Specimens' names were built as follows: a/scPVA80-40g-120°C-free/constr. where a/sc refers to amorphous or semi-crystalline PVA followed by the degree of hydrolysis, 40g denotes the glycerol content in phr and is followed by foaming temperature and surface conditions during foaming *i.e.* free or constrained (see next section for details).

Supercritical foaming. Strips (30mm x 5mm) were cut in the film and clamped between two glass plates as shown in Figure 1. One part of the sample was confined between the supporting glass and the spacer while the other part was free *i.e.* the surface of the film was not constrained. Constraining of the film surface slows down the desorption of CO₂ upon depressurization and can have significant effect on the foaming process of thin polymer films [14]. In our case, fully hydrolyzed PVA could be foamed only in free conditions while partially hydrolyzed PVA, all wet films and HPC films foamed only under constrained conditions.

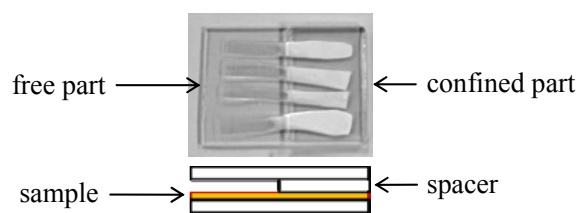


Figure 1. Sample holder and surface condition during the foaming process.

PVA samples were saturated by supercritical CO₂ at 20MPa (at lower pressures, no foaming occurred) and foaming temperature varied from 80°C to 170°C. HPC samples were saturated at temperatures starting from 35°C up to 120°C and saturating pressure varied from 10MPa to 20MPa. The pressure release rate was of 10MPa/s.

Morphological characterization. Foamed samples were fractured in liquid nitrogen and coated by platinum. Morphological observations were carried out on a JEOL JSM-6700F field emission scanning electron microscope. The cell density was calculated as follows:

$$N = \left(\frac{n}{A} \right)^{\frac{3}{2}}, \quad (1)$$

where N denotes the cell density, n the number of cells counted on a SEM image and A the analyzed area in cm². The cell density taking into account the expansion ratio *i.e.* relative to unfoamed volume was then calculated as follows:

$$N_c = N \cdot \left(\frac{1}{1-P} \right)^{\frac{3}{2}} \quad (2)$$

where P stands for porosity of the foam as measured on the SEM image and expression in the brackets represents the expansion ratio denoted as V_e in Table 1.

Results

Foaming of amorphous and semi-crystalline PVA with glycerol as a plasticizer. Semi-crystalline PVA could not be foamed with supercritical CO₂ without plasticizer due to thermal degradation of the polymer starting at temperatures around 140°C. On the other hand amorphous PVA, specially designed by Nippon Gohsei to widen the temperature range available for melt casting; could be foamed at 170°C. As shown in Figure 2a, aPVA foam displayed uniform morphology with average cell size of 2µm and overall porosity of 39.5%. Further increase in foaming temperature or constraining of the film surface during foaming resulted in larger cells but also in formation of cracks inside the film (not shown) likely due to the coalescence of neighboring cells so that it was not possible to significantly increase the overall porosity and cell size of the neat aPVA foam.

In view of cellulose nanocomposites foaming, the use of plasticizer was investigated in order to decrease the foaming temperature limited to cca 160°C due to oxidation occurring at the polymer-cellulose interface at higher temperatures [15]. By varying the amount of plasticizer from 20phr to 60phr, the cell size and overall porosity of the film could be tailored as shown in Figure 1b to Figure 1d and summarized in Table 1. It is interesting to note that foaming of aPVA with 40phr of glycerol at 120°C gave comparable foam morphology as foaming of neat polymer at 170°C (see Figure 2a and 2c). Increase of the glycerol content resulted in formation of larger cells and higher film porosity however the cell density decreased to $6.01 \cdot 10^{10}$ cells/cm³ suggesting higher coalescence rate. On the other hand, increase of foaming temperature at given glycerol content did not affect the cell density while the foam porosity was slightly decreased.

Morphology of semi-crystalline PVA foam containing 40phr of glycerol and foamed at 120°C with constrained surface is displayed in Figure 2h. While the level of porosity remained around 40%, the cell density increased. This can be related to the presence of residual PVAc groups resulting in higher CO₂ solubility and also lower surface tension, both parameters being able to enhance the nucleation rate. Also amorphous-crystalline interface may act as heterogeneous nucleating sites.

However, the increase in cell density compared to neat aPVA is only slight. Increase of foaming temperature to 140°C led to significant increase in porosity (65.3%) and cell diameter (5.46µm) while the cell density dropped by one order of magnitude. Effect of temperature is in this case coupled with the confinement of the film surface slowing down the gas desorption. Therefore, longer time is available for the cell growth and at the same time diffusion is faster because the film is more plasticized. Despite high porosity and bigger cell size, foam kept closed morphology.

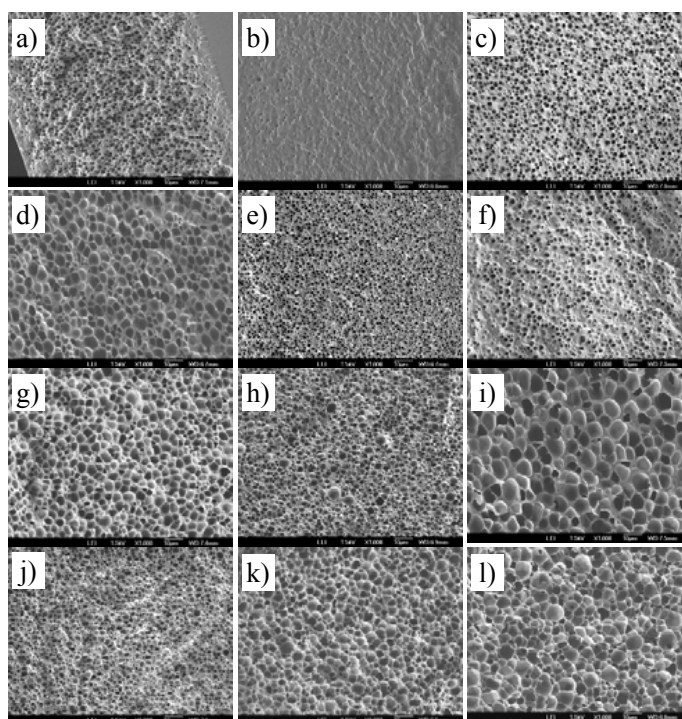


Figure 2. Morphology of PVA foams obtained at different foaming conditions: a) aPVA-170°C-free, b) aPVA-g20-120°C free; c) aPVA-g40-120°C-free; d) aPVA-g60-120°C-free; e) aPVA-g40-140°C-free; f) aPVA-wet-100°C-free; g) aPVA-wet-120°C-free, h) scPVA88-g40-120°C-constr., i) scPVA88-g40-140°C-constr., j) scPVA80-wet-80°C-constr., k) scPVA80-wet-100°C-constr., l) scPVA72-wet-100°C-constr.. Magnification is of 1000x and scale bar corresponds to 10µm.

Using water as temporary plasticizer. As the use of glycerol affects the mechanical and barrier properties of PVA films, we tried to use water as a temporary plasticizer. PVA films were stabilized in regulated chamber (23°C, 80%RH) resulting in moisture content of 18% for aPVA and cca 14% for scPVA. Morphology of foams obtained by blowing aPVA wet films at 100°C and 120°C is displayed in Figure 2f and 2g. It is interesting to note that wet aPVA films could be foamed only with constrained surface indicating higher diffusion rate in the film compared to glycerol plasticized ones. Foam

morphology obtained at 100°C is comparable with the neat aPVA foamed at 170°C. However, when foaming temperature exceeded 100°C, moisture seemed to act as co-blowing agent as can be seen from increased cell size and porosity of the film blown at 120°C displayed in Figure 2g. While the cell density obtained at 100°C is comparable to that of the neat polymer, at 120°C the cell density dropped. Similar results were obtained for scPVA as shown in Figure 2j to 2l. Moisture content could be successfully used to foam PVA films at low temperatures and tailor the cell size and porosity of the film.

Table 1. Summary of morphological descriptors of PVA foams.

Specimen name	d (μm)	P (%)	N (10^{10}cm^{-3})	V_e (-)	N_c (10^{11}cm^{-3})
aPVA-170°C	1.6	39.4	8.9	2.1	1.9
aPVA-g20-120°C	1.0	14.7	8.4	1.3	1.1
aPVA-g40-120°C	1.6	36.4	7.7	2.0	1.5
aPVA-g60-120°C	3.6	61	1.5	4.1	0.6
aPVA-g40-140°C	1.5	31.0	8.5	1.7	1.5
aPVA-wet-100°C	1.7	33.3	5.7	1.8	1.1
aPVA-wet-120°C	3.3	54.5	1.7	3.3	0.6
scPVA88-g40-120°C	1.6	40.8	10.5	2.2	2.3
scPVA88-g40-140°C	5.5	65.3	0.5	4.9	0.2
scPVA80-wet-80°C	1.8	47.7	8.8	2.6	2.3
scPVA80-wet-100°C	2.9	64.9	3.1	4.8	1.5
scPVA72-wet-100°C	4.1	69.2	1.8	5.9	1.1

Legend: d is the average diameter of the cell, P stands for porosity, N is the cell density, V_e is expansion ratio and N_c is the cell density relative to unfoamed polymer volume.

Foaming of hydroxypropyl cellulose films. Second example of hydrophilic polymer that we studied was HPC. HPC is more compliant than PVA and could be foamed at very low temperatures starting from 35°C. When saturated at 20MPa, HPC foams exhibited cells around 2-3 μm up to foaming temperature of 60°C (*cf* Figure 3c) while at higher temperatures the cell size was of cca 5.8 μm but did not increase with further increase in temperature up to 120°C. Variation of saturation pressure at low temperatures allowed for tailoring of the morphology as displayed in Figure 3. Lower pressures resulted in higher porosity of the film and larger cells while higher pressures led to smaller cells. Especially high pressures led to interconnected morphology likely due to low strength of softened HPC during the foaming process resulting in combination of neighboring cells.

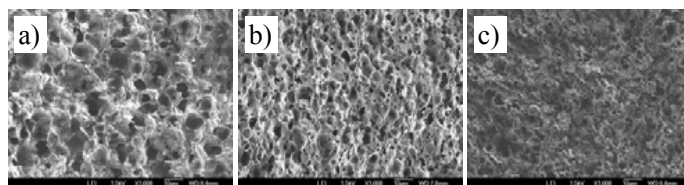


Figure 3. Morphology of HPC foams obtained at 60°C with constrained surface for different saturating pressures: a) 10MPa, b) 15MPa, c) 20MPa. Magnification is of 1000x and scale bar corresponds to 10 μm .

Conclusions

In the present study, the foamability of hydrophilic polymers namely PVA and HPC was investigated in view of foaming cellulose nanocomposites. It was found that PVA could be foamed below 160°C only with the use of plasticizer. Besides glycerol, moisture content revealed to be very efficient temporary plasticizer allowing for foaming both aPVA as well as scPVA films at temperatures starting at 80°C. HPC films could be blown with supercritical CO₂ at such low temperatures as 35°C and morphology could be tailored by changing saturation pressure. However, HPC foams exhibited often partially interconnected morphology and cell size was bigger than in the case of PVA that showed nicely defined closed morphology with cell size around 1 μm and porosity of cca 40%.

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Key Words: Supercritical foaming, Hydrophilic

Best Papers in TPM&F Division for ANTEC® 2011 Conference



Best Paper in **Thermoplastic Materials:**

Barrier Property and Characteristic of Polyglycolic Acid for Un-Oriented Sheets and Oriented Films

by Daisuke Ito and Kazuhisa Takatsuji, from KUREHA CORPORATION

Abstract

Measurement of oxygen permeability of biodegradable polyglycolic acid (PGA) un-oriented amorphous and crystallized films, and oriented films showed superior values versus general barrier materials. The effect of orientation and crystallization was investigated, showing that oxygen permeability was dependent upon the polymer's free volume and its degree of crystallinity. By stretching an un-oriented amorphous film, PGA chains became highly oriented, resulting in increased temperatures of glass transition and tand peak. PGA's carbon dioxide barrier was tested using PET/PGA multilayer bottles, with 1 and 3wt% PGA bottles showing 1.5 and 2.5 times better gas barrier, respectively, versus a PET monolayer bottle.

Best Paper in **Foams:**

The Effect of Chain Branching on the Crystallinity Behavior of Polylactide with the Presence of Dissolved CO₂

by W. Zhu¹, M. Nofar¹, W. Zha¹, C. B. Park¹ and J. Randall²

¹Microcellular Plastics Manufacturing Laboratory, Department of Mechanical and Industrial Engineering, University of Toronto.

²NatureWorks LLC.



Abstract

This paper investigates the effect of chain extender on the crystallinity behavior of Polylactide with/without the presence of dissolved CO₂ by a high-pressure differential scanning calorimeter (HPDSC). It is shown that without CO₂, the crystallinity increases by decreasing the branched structure due to better chain regularity. With the presence of low-pressure (15bar) CO₂, the crystallinity of PLAs significantly increased due to CO₂'s great plasticization effect. However, with the increase of pressure (from 15bar to 45bar), crystallinity dramatically decreases, even though more CO₂ is dissolved. However, as the pressure increases from 45bar to 60bar, the crystallinity of all PLAs dramatically increases.

— **Lukas Stirnemann**

FOAMS®2011 RECAP – Sal Monte

COPY REPRINTED FROM SPE PALISADES-NEW JERSEY NEWSLETTER (JENNIFER MARKARIAN EDITOR), EVENT PHOTOS BY ROBERT KAPPUS

Thanks to all who made the FOAMS® 2011 Ninth International Tutorial & Technical Conference on Foams Processing & Technology a success! The tutorial and conference, sponsored by the TPM&F [Thermoplastic Materials & Foams] Division and the Palisades-New Jersey Section, were held in Iselin, NJ from September 12-15. Conference Chair Salvatore J. Monte, Co-Chair Rich Bradley, Technical Program Chair Dr. Miguel Angel Rodríguez Pérez, and Committee members Francis McAndrew, Theresa Healy, Dr. Maxwell Wingert, Michael Reedy, Dale Grove, Bob Kappus, Cheryl Kappus, Mike Carnese, and Erika Monte all worked hard to present a high-quality program.

The two-day tutorial was instructed by Dr. S.T. Lee, Sealed Air Corporation – co-author of “Polymeric Foams – Mechanisms and Materials” along with Dr. N.S. Ramesh – last year’s tutor for the lead-off segment; Dr. Chul B. Park, Professor at the University of Toronto, holder of a Canada Research Chair in Microcellular Plastics and Director of the University’s Microcellular Plastics Manufacturing Laboratory; and Dr. Hani Naquib, Associate Professor at the University of Toronto and holder of a Canada Research Chair in Smart and Functional Polymers. At the tutorial, 22 attendees from all over the globe learned the basics of foaming, discovered how to apply scientific principles to improve existing foaming technologies, and heard about state-of-the-art foaming technologies. As one seasoned customer technical business manager commented, *“I found the Tutorial to be worth my time. The instructor was able to take fundamental principles in Foams technologies and apply to practical situations that I deal with every day.”*



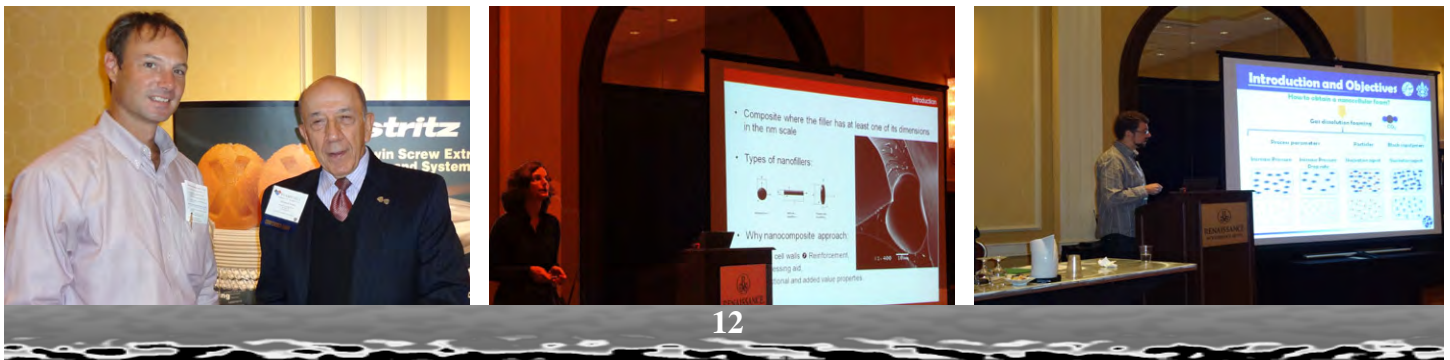
The technical conference featured 23 presentations by industry experts and had over one hundred attendees from the USA, Canada, UK, Spain, Germany, and Japan. Nicole Whiteman of NatureWorks LLC gave the plenary address on “Addressing Sustainability by Innovating with Ingeo Biopolymer Foam”. Dr. Robert C. Fry, Jr. from the DuPont Economist’s office presented the luncheon address on current business developments in the U.S. and Global economies.

Dr. Dale Grove was responsible for selecting the five best technical papers for review. Of these, the Best Paper Award went to Jana Dlouhá and Hiroyuki Yano of the Laboratory of Active Bio-based materials, Research Institute for Sustainable Humanosphere at Kyoto University for their paper titled “Foaming of Hydrophilic Polymers Using Supercritical CO₂”.

A Student Poster Session included presenters from Brunel University, UK; The Ohio State University, USA; Kyoto University, Japan; the University of Washington, USA; and the New Jersey Institute of Technology, USA jointly presented with the University of Rhode Island, USA. Dr. Maxwell Wingert chaired the Poster Session awards committee and the poster on “Polymeric Foams for Oral Drug Delivery, A Review” by G. Terife, N. Faridi, P. Wang, and C.G. Gogos of NJIT was declared the winner.

The TPM&F Division and the Palisades-New Jersey Section would also like to thank Gold Sponsors Clariant and Reedy International; Coffee Break Sponsors Dow and Rowa Inc.; and Exhibitor Sponsors Dow, Kenrich Petrochemicals Inc., Leistritz, Rowa Inc, and Quantachrome Instruments.

“The SPE Thermoplastics Materials and Foams Division is grateful for the cooperation of the Palisades-NJ Section and its volunteer members for a successful conference. We held the first FOAMS® ’99 Conference in NJ and we were happy to be back a third time. Next year, FOAMS® 2012 will be in Barcelona – most likely during the second week in September under the leadership of Dr. Miguel A. Rodriguez-Perez. FOAMS® 2012 will continue the mission of SPE – to provide professional educational opportunities to its members”, said Mr. Salvatore J. Monte, FOAMS® 2011 Chairman.



Treasurer's Report

Report for End of FY2011 (7/1/10 - 6/30/11)
September 13, 2011

Financial Summary:

Ending FY2011 division balance is \$149,770.52, up by \$4,083.37 from the previous year end balance of \$145,687.15. The gain during FY2011 comes despite a budgeted loss for the fiscal year. The reason is largely due to under-spending for the SPE foundation and Outstanding Achievement Award categories. FY2011 actual income were \$19,256.98 versus a budgeted \$19,000. FY2011 actual expenses were \$15,173.61 versus a budgeted \$23,200.

The Educational Programs category has now been split into two categories:

Educational Programs is the category for miscellaneous events involving students, either those at universities or K-12. Technical Training Seminars is the category for our webinars and other similar projects we may undergo. The FY2012 proposed budget is shown below. The Educational Program category is currently budgeted for \$5,000: \$1,000 for Plasti-van; \$4,000 for the ANTEC Student Activities Committee --- half for a payment for the FY 2010 fiscal year and half for the FY2011 fiscal year. If we decide to alter the contribution to this organization to \$15,000, the budget for this category will become \$18,000.

Many thanks to past treasurer Wen Wu for further assistance.

	FY2010 6/30/10 Actual	FY2010 Budget	FY2011 6/30/11 Actual	FY2011 Budget	FY2012 Budget
INFLOWS					
Interest & Dividends	\$ 5.40	\$ 50.00	\$ 0.47	\$ -	\$ -
SPE Investment Program	\$ 2,954.17	\$ 2,000.00	\$ 4,055.17	\$ 2,000.00	\$ 4,000.00
Sponsorship	\$ -	\$ 1,000.00	\$ 500.00	\$ 1,000.00	\$ 500.00
Conference - FOAMS	\$ 7,918.54	\$ 8,000.00	\$ 8,012.45	\$ 8,000.00	\$ 8,000.00
Conference - Polyolefins	\$ 6,364.13	\$ 6,000.00	\$ 5,448.30	\$ 6,000.00	\$ 5,500.00
Member-Get-A-Member	\$ -	\$ -	\$ 75.00	\$ -	\$ -
SPE Rebate	\$ 770.41	\$ -	\$ 1,165.59	\$ 2,000.00	\$ 1,000.00
Total Inflows	\$ 18,012.65	\$ 17,050.00	\$ 19,256.98	\$ 19,000.00	\$ 19,000.00
OUTFLOWS					
ANTEC expenses	\$ 2,500.00	\$ 1,500.00	\$ 3,480.00	\$ 2,000.00	\$ 4,000.00
Best paper awards	\$ 268.69	\$ 2,400.00	\$ 11.58	\$ 500.00	\$ 200.00
Board Meeting	\$ 2,968.28	\$ 4,500.00	\$ 2,652.11	\$ 4,000.00	\$ 3,500.00
Councilor Travel	\$ 1,301.33	\$ 1,500.00	\$ 425.98	\$ 1,500.00	\$ 1,500.00
Educational Programs	\$ 500.00	\$ 3,000.00	\$ 1,000.00	\$ 1,350.00	\$ 5,000.00
General Office	\$ 62.92	\$ 200.00	\$ 86.10	\$ 200.00	\$ 200.00
Newsletter Printing/Mailing	\$ 1,951.00	\$ 2,800.00	\$ 1,133.00	\$ 2,000.00	\$ 2,000.00
Outstanding Achievement Award	\$ 35.91	\$ 5,000.00	\$ 2,946.18	\$ 5,000.00	\$ 4,500.00
Scholarships/Grants	\$ -	\$ -	\$ -	\$ -	\$ -
SPE Foundation	\$ 2,500.00	\$ 4,000.00	\$ -	\$ 4,000.00	\$ -
Technical Training Seminars	\$ -	\$ -	\$ 1,650.00	\$ 1,650.00	\$ 1,500.00
Other expenses	\$ 2,333.99	\$ 1,000.00	\$ 1,788.66	\$ 1,000.00	\$ 1,000.00
Total Outflows	\$ 14,422.12	\$ 25,900.00	\$ 15,173.61	\$ 23,200.00	\$ 23,400.00
Overall Surplus (deficit)	\$ 3,590.53	\$ (8,850.00)	\$ 4,083.37	\$ (4,200.00)	\$ (4,400.00)
Budget Plan	\$ (8,850.00)	\$ (8,850.00)	\$ (4,200.00)	\$ (4,200.00)	\$ (4,400.00)
Variance from Budget	\$ 12,440.53	\$ -	\$ 8,283.37	\$ -	\$ -
Ending Account Balance	\$ 145,687.15		\$ 149,770.52		

- Maxwell Wingert

TPM&F Board of Directors Meeting FOAMS® 2011, Iselin, NJ September 13, 2011

The TPM&F Board of Directors meeting was held on September 13th, 2011 at FOAMS® 2011 in Iselin, NJ at 6:30pm. Attending the BOD meeting (In person)-Perry Vadhar, Sal Monte, Erika Monte, Theresa Healy, Dale Grove, Max Wingert, Miguel Rodriguez-Perez, N.S. Ramesh, Chul Park, and Hani Naguib. Joining the BOD meeting by phone-Xiaoxi Wang, Lukas Stirnemann, Ray Shute, Donna Davis, and Camilo Cano and Vipin Kumar.

Chair Report-Perry Vadhar-Perry thanked those involved in the FOAMS® 2011 event. He mentioned that Bill Arendt asked us to share the minutes and write a paragraph so he can communicate the highlights of the meeting with the Executive VP. Perry encourages all to attend the SPE leadership meetings. He will send an e-mail with details on it. Minutes from last Meeting-The minutes from the last meeting held at the ANTEC® 2011 were approved.

FOAMS® 2011 Report-Sal Monte is Conference Chair for this event. Miguel Perez is the Technical Chair. Sal reminded all the moderators to have the framed certificates ready for the speakers for the session they are moderating. Sal will take care of speakers to get their flash drives so their presentations can be loaded on the computer. Currently, the registered attendees for the FOAMS® 2011 event are 105. Sal reminded everyone that the purpose of the SPE is to educate its members and provide professional training.

Tutorial Update-Chul informed there were 22-25 attendees for the tutorial.

Poster Sessions-Max Wingert said that he has 5 students that will be presenting posters during the FOAMS® 2011 event. Three of them are from the US. There will be an award presented to one student and a \$250 cash prize. He will submit the print outs for judging.

Sponsors-Theresa Healy (*Sponsorship Chair*) mentioned there are 7 sponsors total (*2 Gold, 2 Coffee break*) which generated \$10K in revenue. Ray Shute shipped the sponsorship plaques to Rich Bradley to be given out during the awards ceremony.

Best Paper's Chair Report-Dale Grove thanked Max and Joe for helping him judge the papers during the conference. Ramesh will also help with the judging. They are down to the final 5. Lukas mentioned that he has the template for the awards if needed that includes the name and title of the presentation. Sal mentioned that SPE headquarters (*Lauren McCarthy*) has a template and if you provide the name and the title, Lauren will print out the certificates and send them to you.

FOAMS® 2012 Plans- There was a lot of discussion about whether or not to hold the FOAMS® 2012 event in Barcelona. There was also concern about this event competing with the RAPRA. However, the technical papers from the SPE are geared more technical for the FOAMS® event and less commercial and the cost is more economical. Miguel requested that we make a decision very soon as we need to begin to promote the event and solicit papers. Therefore, a motion was made and approved to hold the FOAMS® 2012 conference in Barcelona, Spain. Miguel Perez volunteered to Chair this event in Spain and Miguel with work on finding quality papers. The dates of the FOAMS® 2012 will be 9/17 & 9/18 Tutorial and 9/19 & 9/20 will be the conference. Announcement regarding next year's venue will be mentioned during the FOAMS® 2011 Conference. It will also be placed in the Newsletter as well as on Linked In.

FOAMS® 2013-There was some discussion about having FOAMS® 2013 in Seattle or possibly in Chicago. More discussion will take place at the Polyolefins Conference in February.

Treasurer's Report- Max Wingert reported the following financial summary:

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The Educational Program category is currently budgeted for \$5,000: \$1,000 for Plastivan; \$4,000 for the ANTEC® Student Activities Committee --- half for a payment for the FY 2010 fiscal year and half for the FY2011 fiscal year. If we decide to alter the contribution to this organization to \$15,000, the budget for this category will become \$18,000. Many thanks to past treasurer Wen Wu for further assistance. A motion was passed on 9/13 to approve the treasurer's proposed budget as indicated in the report above.

PO 2012 TopCon Report-Andy Chatterjee/Donna Davis. Andy was not online but he is soliciting for this TopCon. Donna mentioned she has 5 out of 6 talks for rigid packaging.

Education Chair Report-Hani Naguib mentioned that there was a proposal by Leslie Kyle for this division to donate \$15K to cover Student Activities at ANTEC® 2012. The board discussed this amount and felt that our division could donate \$5K. Therefore, a motion was made by Hani to approve the amount of sponsorship to \$5K for student activities which includes platinum sponsorship for the ANTEC® for this year only. Motion was approved. Hani mentioned that there was a \$1K donation to Plastivan that should continue this year.

Webinar Series-Perry and Hani will work on putting together another series of webinars. They are thinking about starting up again in January. They will contact Cereplast, Purac and Tianan as a potential for the Biofoams Series. Hani will follow up with the speakers. Donna Davis brought up a good point that we had discussed advertising the webinar series to promote the upcoming conferences. Hani mentioned that we had to change that approach because we missed it for the FOAMS® 2011. We can go back to that approach or we can come up with new topics. Hani will investigate some speakers and come back on a proposal. Scholarships-TPM&F would like to have feedback from the students who receive these scholarships. There was some confusion as to the amount of scholarship money and Max mentioned that we have not sent out a check during FY 2010-2011. There will be a review of the minutes and Hani will check with Kelvin about how the money was spent in the past. There was discussion about dedicating the money to fund the webinars instead.

Outstanding Achievement Award Chair Report-Vipin Kumar mentioned that last year the award was given to Walter Schrenk. We need to find someone from the industry to honor. Vipin would like to have this finalized in early January. Forward any nominations to Vipin by 11/15. Chul mentioned that he has a good candidate (Dr. Klaus Han) who is dedicated to FOAMS®. He is also located in Europe so we can hold the ceremony in Europe during Foams 2012. Chul will put something together on this candidate and send it to Vipin.

HSM/Fellows Nomination-Donna Davis-No active applications for honor service member at this time. If you have a recommendation, submit it to Donna.

Communication Chair Report-Theresa Healy will work closely with Xiaoxi Wang on anything we want to communicate to our members. TPM&F Linked-In site-We currently have 218 members. We have uploaded information on the FOAMS event. If anyone has information on other TopCons that they want to upload, please submit your data to Theresa and she will upload them on the site.

Website-Theresa discussed having this division have their own website to promote memberships and increase communication efforts. Sal mentioned that he can supply a quotation on a web designer that he works with. We will need to get some quotations on this website proposal. Perry will also inform a name of a web designer.

Membership Report-Camilo Cano mentioned that the enrollment numbers at the end of August were 961-TPM&F. 23 members joined since the end of March. Camilo will obtain more information from Tricia to understand these numbers in more details. He is going to develop a proposed plan to get those memberships to remain. Last meeting Dale Grove had made some good suggestions.

Newsletter Chair Report-Xiaoxi Wang mentioned that there were 4 newsletters planned this year: October 2011, Late January/Early February 2012/Early March 2012/Early May 2012. He will try and obtain some sponsorships as no one is actively soliciting. He did receive a commitment from Reedy to sponsor again. He will send out solicitation e-mails for information for the newsletters with deadlines. He wants to achieve the "Notable Achiever" award this year if possible.

Nomination Chair-Ray Shute mentioned that we currently have a full board. Two BOD members did not make the list. Dale is not officially on the board but is next in mind. Next Election will take place before the ANTEC® on July 1st. Revision of TPM&F By-laws-Kelvin Okamoto was going to revise the bylaws. Perry will follow up with Kelvin on the status. Next BOD Meeting-Polyolefin Conference at 7:00pm on February 27th, 2012. Meeting was adjourned at 9:20pm.

- Lukas Stirnemann

TPMF Councilor's Report:

September 13, 2011

Mid-Year Financial Update

SPE posted gross revenues as of June 30 of \$2,376,830 compared to \$1,948,486 for the same period last year. This represents a 21% increase, realized mainly as a result of a very successful showing at ANTEC®. Total operating expenses were \$1,815,806. This resulted in a net income for the first six months of 2011 of \$561,024. This compares very favorably to net income as of June 30, 2010 of just over \$100,000. In historical context, this is by far the best year on record since 2000

2010 Audit

The 2010 audit is complete and a final report is attached to this issue of Leadership e-News. It was also published in the summer issue of Plastics Engineering. There were no findings and the final numbers were consistent with prior reports to Council. Overall, in 2010, SPE posted net incomes of \$133,000.

ANTEC® 2012 Dates

ANTEC® 2012 will be co-located with NPE and held in Orlando, Florida, at the Orange County Convention Center. ANTEC will be held April 2-4; NPE will be held April 1-5. [Click here to submit](#) your abstract/paper. An early abstract is not required; the [abstract and paper deadline](#) is October 19, 2011.

Fellow and HSM Applications

Reminder: Applications for Fellow of the Society and Honored Service Member are available on the SPE website. Applications are due September 20, 2011, so you may want to start the application process now! [Fellows application](#). [HSM application](#). Questions can be directed to [Sarah Sullinger](#) (+1 203-740-5422).

Annual Awards Nominations Being Accepted

The SPE Annual Awards Committee is presently seeking nominations for 2012 awards. These prestigious awards, recognizing excellence in the plastics industry by individuals who have made outstanding contributions or lifetime achievements in plastics, are presented each year at ANTEC®. Nominations are being accepted for the International Award, the Business Management Award, the Education Award and the Research/Engineering Technology Award. All awards include a cash honorarium and a plaque or, for the International Award, a gold medal.

2011-2012 Rosters

The 2011-2012 SPE year began on July 1, and we want to ensure that we have an accurate leadership roster for your group so your board members receive information sent from SPE Headquarters. Please download our leadership roster template from the SPE website and email the completed form to Leadership Services as soon as possible. The form is also available on the Leadership Services web page under the category Operations/General Information.

Board Meetings and Events

Please send 2011-12 event information to SPE Headquarters using the Upcoming Event notification form located on the SPE [website](#). SPE Headquarters helps to promote your events by posting details to your group page and to the SPE calendar of events, a feature that is persistent throughout the website. Groups can submit a calendar of activities or send updates and new event details as they become available.

– Ashu Sharma