MOLDING VIEWS

spe INJECTION MOLDING

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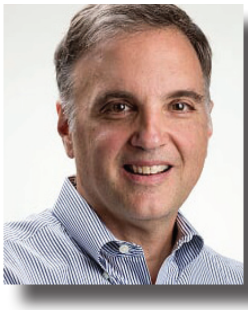
Fall 2020 | No. 112

Chair's Message

Rick Puglielli



As social beings, some of us become more and more rigid with our daily routines especially as we get older. The COVID-19 pandemic is now giving us the ultimate test of our flexibility not only in our personal lives but in our business lives as well. As we continue to adapt to a new normal, SPE and the IMD are doing the same. Within two weeks before ANTEC 2019 was scheduled to begin in late March, most of the country was starting to shut down and travel bans were being imposed. With many attendees already committed and technical speakers ready to go, SPE was able to quickly adapt and turn the whole event into a virtual conference. Although it was extremely challenging, most everyone was able to quickly adapt and make it a successful event. This is the kind of flexibility that makes individuals and organizations thrive. If something does not flex then it will break. So, remember that the more you resist change, the less flexible you are and when you do not flex and adapt to change, the more likely you are to crack, snap or just lose your mind. With much uncertainty still on the horizon, change is inevitable. Nonetheless, SPE and the IMD are still planning and working on new future events and hoping that the hybrid model of ANTEC will be able to safely launch in 2021. Stay safe, healthy and flexible.

Sincerely,

Rick Puglielli
2019-2020 IMD Chair
Promold Plastics
info@promoldplastics.com

In This Issue:

This Month's Features:

Keep the connection!
Join us on:

Industry Events/Webinar Calendar

Click the show links for more information on these events!

November 2020

HOW TO REDUCE RISK IN PLASTIC PART DESIGN AND MANUFACTURING

November 9, 2020
2:00 PM ET

In this webinar Autodesk will explore how companies today use simulation workflows to identify potential issues, detect the significance of interaction effects between variables, and define custom quality criteria to produce a part with the least amount of risk. The information from simulation results can even be transferred to set up injection molding machine processes for quicker start up. Join Autodesk to find out more.

Primary Topics:

- Learn how simulation can be used to reduce manufacturing risk
- Using Design of Experiments to make more informed decisions
- Quicker machine startup with simulation input

More information>

Industry Events/Webinar Calendar

WEBINAR:
NAVIGATING PLASTIC MATERIAL SELECTION

Thursday, November 12, 2020
11:00 AM - 12:00 PM (EST)

Webinar via Zoom
FREE for SPE Members, Non-Members: $199

Material selection is one of the fundamental aspects that will determine the success or failure of a product. With so many choices available today regarding plastic materials, it is imperative that anyone involved in product design or material selection understand resin properties and how they will affect end product performance as well as part design and manufacturability. While plastic material selection is a frequent topic of discussion, it is not as simple as it may first appear. A thorough understanding of the short-term and long-term properties of the potential plastic resins is essential. To help make the best plastic resin choice, is also essential to have a basic knowledge of polymer chemistry. **More information>**

WEBINAR:
THE LIFE OF A PLASTIC COLOR

Tuesday, November 17, 2020
11:00 AM - 12:00 PM (EST)

Webinar via Zoom *FREE*

With increasingly complex color palettes and other specifications like flame retardation and recyclability coming into play, plastic color can be challenging to produce. However, with the right tools, processes and basic color understanding at hand, color doesn't have to be a burden in producing plastic product.

During this webinar hosted by SPE, X-Rite Pantone color experts will help you understand the life of a plastic color and how your particular role in that lifecycle can help expedite the product development process, from inspiration and design all the way through final quality control.
More information>

ANTEC® 2021
THE HYBRID EDITION

Call for Technical Papers

Topics include:

- Additive Manufacturing
- 3D Printing
- Advanced Energy
- Alloys and Blends
- Applied Rheology
- Automotive
- Bioplastics & Renewable Technologies
- Blow Molding
- Building and Infrastructure
- Color & Appearance
- Composites
- Decorating and Assembly
- Electrical & Electronic
- Engineering Properties & Structures
- Extrusion
- Failure Analysis
- Flexible Packaging
- Foams
- Injection Molding
- Joining of Plastics and Composites
- Medical Plastics
- Mold Technology
- Plastic Analysis
- Plastic Pipe and Fittings
- Plastics Recycling
- Polymer Analysis
- Polymer Modifiers & Additives
- Product Design & Development
- Reaction Injection Molders
- Rotational Molding
- Sustainability
- Thermoforming
- Thermoplastics Elastomers
- Thermosets
- Vinyl Plastics

PAPER SUBMISSION DEADLINE:
November 15, 2020 (NO EXTENSIONS OR EXCEPTIONS)

For questions about papers and the technical program, contact:

David Anzini
ANTEC® 2021 Technical Chair
david.anzini@celgard.com

By Yann-Jiun Chen [1,2] , Matthieu Fischer [1], Chao-Chang A. Chen [2], and Ines Kuehnert [1]*

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Leibniz Institute for Polymer Research, Dresden, 01069, Germany
[2]Department of Mechanical Engineering
National Taiwan University of Science and Technology, Taipei, 10607, Taiwan

Study on Thermal Characteristics and Mechanical Properties of Poly (Lactic Acid)/ Paraffin Wax Blends

Abstract

Poly (lactic acid) (PLA) plastics have been popularly applied on many bio-degradable products and claimed as a green polymer materials for environmental concerns. In this study, a poly(lactic acid) (PLA)/paraffin wax (PW) composites with blends containing different amounts of PW and different compounding times have been developed and investigated. These composites blends were prepared by a micro-compounder with twin screw. Then, a neat PLA and the PLA/PW composites have been used to fabricate tensile specimens by micro injection molding machine. Effects caused by different compounding time and PLA/PW ratios, the thermal behavior and mechanical properties have been tested and investigated. Moreover, distribution and dispersion of PW in the PLA matrix have been observed in optical microscope and then calculated for comparison. Experimental results showed that the addition of PW yields significant improvements in ductility and toughness compared to that of neat PLA. The crystallinity and complex viscosity have also been improved. Finally, the samples of PLA/PW made by longer compounding time exhibits better distribution. Results of this study can be used for developing PLA/PW composites for bio-prosthesis for implants applications.

Keywords: poly (lactic acid); paraffin wax; compounding time; injection molding;

Introduction

In the past decades, polymers materials have contributed to popularity of technical products to human life. Some polymers such as polyethylene, polystyrene, polypropylene, and poly (vinyl chloride) are widely used in disposable products suitable for mass production. However, polymer pollution has become a serious issue to living environment[1]. Nowadays, poly (lactic acid) (PLA) has become one of the most popular biomaterials since it is made from agricultural sources such as starch, cellulose, roots, or sugarcane, which makes it widely available for use in food packaging, disposable utensils, medical devices, and structural applications[2-6].

However, the biodegradable properties of PLA also limit its potential applications. PLA is inherently brittle and has a slow crystallization rate, low thermal resistance, and higher viscosity when molten[7, 8]. Thus the PLA composites with other additive materials need to be investigated. In previous studies, paraffin wax (PW) has been used as a filler for the PLA matrix to investigate the thermal properties, mechanical behavior, and morphology of PLA/PW blends[9]. This is because paraffin wax is chemically inert, is an excellent lubricant, is commercially available at a low cost[10], undergoes ductile failure at low strain rates[11], and is water resistant. Paraffin wax has also been used in research as a sacrificial material[12-15], phase change material [16-18], and food additive[19, 20].

This study focuses on the effects of the compounding time and the paraffin wax ratio in the PLA/PW composites. Due to the physical properties of paraffin wax, it is expected that the hydrolysis degradation and water resistance of the blends can be superior to that of the neat PLA.

Experimental Methods

Processing

Materials

Materials for experimental study including PLA and PW. The Ingeo 3001D, an injection grade poly (lactic acid) (PLA) in pellet form, was purchased from NatureWorks (Minnetonka, MN) and it had a MFR of 22 g/10 min (ASTM D1238), a density of 1.26 g/cm^3, and a 1.4% D-LA content. Purified paraffin wax beads were obtained from LorAnn Products (Michigan, MI) with a density of 0.88 g/cm^3. They arrived as white, odorless beads and were used as received.

Material Preparation and Process Conditions

PLA was melt compounded with paraffin wax at ratios of 15%, 20%, and 25%, and the compounding times were 1, 5, and 10 minutes as shown in **Table 1**. After pelletizing, solid tensile bars were injection molded. An investigation of the thermal properties, mechanical behaviors, water absorption, and rheological behaviors of as-injected specimens have been undertaken to study the effects of the compounding time and the ratio of paraffin wax. A polarized optical microscope is used to characterize the distribution and dispersion of the paraffin wax in the PLA matrix. Mixing of the blends was performed using a Daca micro-compounder (Goleta, CA). The total amount of processed volume was 5cc. Before extrusion, PLA pellets were dried in a vacuum oven at 40 °C for 24 hours to remove any moisture. Prior to injection molding process, the extruded pellets were again dried in a vacuum oven at 40°C for 24 hours. Tensile test bars with a diameter of 0.6 mm were injection molded using a Desma FormicaPlast 2K microinjection molding machine. Some major processing conditions are listed in **Table 2**.

Table 1: Designation of Materials and Their Compositions

Description	Materials	Composition (wt/wt)	Compounding Time (mins)
PLA 1			1
PLA 5	PLA	100/0	5
PLA 10			10
P85/PW15 1			1
P85/PW15 5		85/15	5
P85/PW15 10			10
P80/PW20 1	PLA/PW		1
P80/PW20 5		80/20	5
P80/PW20 10			10
P75/PW25 1			1
P75/PW25 5		75/25	5
P75/PW25 10			10

Table 2: Major Process Conditions

Extrusion	
Temperature (°C) 175 **Screw speed (rpm) 50**	
Injection molding	
Nozzle temperature (°C) 170	Mold temperature (°C) 50
Cylinder temperature (°C) 180	Feed temperature (°C) 170
Injection speed (mm/s) 100	Cooling time (sec) 4.5
First packing phase pressure (bar) 1200	Second packing phase pressure (bar) 700

Characterization

Differential Scanning Calorimetry (DSC)

The thermal behavior of extruded neat PLA and its blends was analyzed using a TA Instruments Q1000 with sealed aluminum pans and a constant nitrogen flow of 50 ml/min. Around 5 to 7 mg of the extruded pellets were used for each measurement. The DSC profile was of a heat/cool/heat cycle from 30°C to 200°C at a rate of 5°C/min under a nitrogen protective atmosphere. All samples were held at 200°C for 5 minutes during the first heating cycle to erase any previous thermal history. The crystallinities of the samples were determined by integrating the enthalpy and entropy peak from 80 to 200°C and calculated with a melting enthalpy of 100% crystalline PLA taken as 93.0 J/g [21].

Polarized Optical Microscopy (POM)

The extruded pellets were cut into 10 μm slices via a Leica RM 2265 microtome to study the distribution and dispersion of paraffin wax in the PLA matrix using a ZEISS microscope. The middle parts of the extruded pellets were sliced and sandwiched between glass slides. Given the obtained POM images, the amount of paraffin wax, as well as its distribution and dispersion in the PLA matrix, can be calculated using a Matlab program.

Rheology

The rheological properties of the extruded pellets were investigated on a TA Instruments ARES-G2 rheometer. The extruded pellets were placed between 25mm parallel plates with a fixed gap of 1.5 mm. The strain amplitude was set at 1%. The frequency sweep was run from a high of 100 Hz to a low of 0.1 Hz at 180°C.

Tensile Properties

Tensile tests were carried out on a Zwick/Roell universal testing machine with a 100kN load cell at a crosshead speed of 3mm/min. Five samples of each composition were tested to obtain the tensile stress vs. strain curves and to examine the consistency of the results.

Results and Discussion

Thermal behavior by DSC

The DSC thermograms recorded during the second heating scan of the paraffin wax, PLA, and PLA/PW blends are shown in **Figure 1**. It can be seen from **Figure 1** and **Table 3** that, with the addition of paraffin wax, the cold crystallization temperature decreased slightly and the crystallinity increased. The presence of

Figure 1: DSC Thermograms of (a) Paraffin Wax and Neat PLA, and (b–d) PLA/PW Blends.

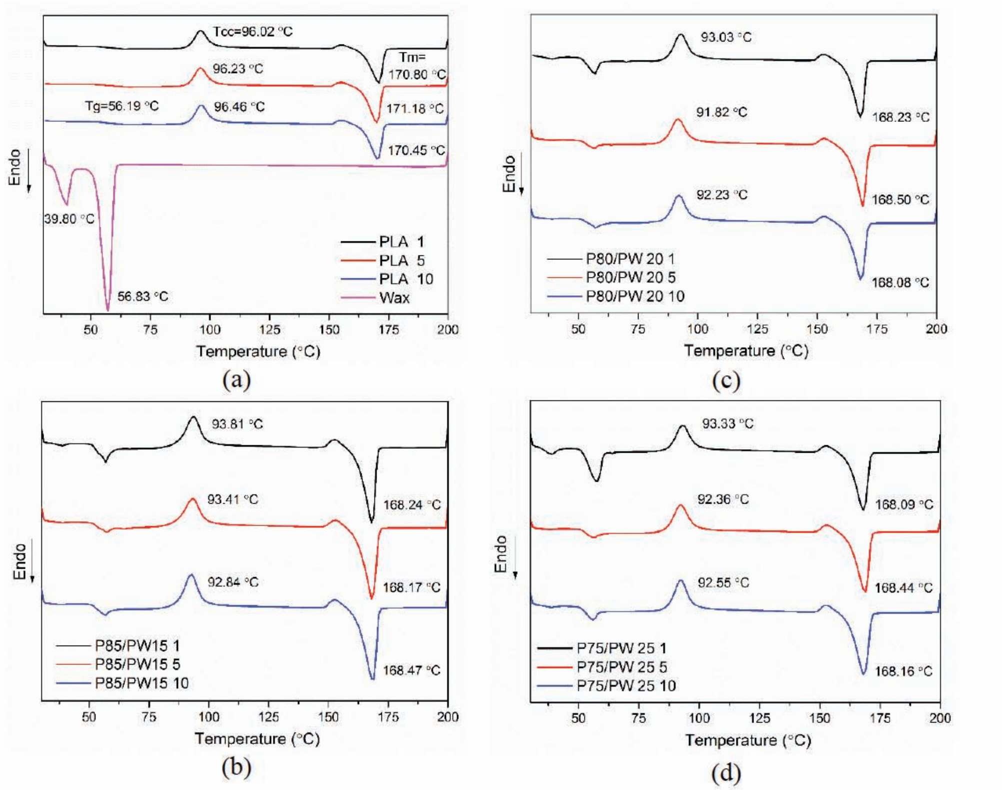


Table 3: The Crystallinity of Neat PLA and its Blends

Material	Xc (%)
PLA 1	8.1
PLA 5	8.1
PLA 10	8.1
P85/PW15 1	14.9
P85/PW15 5	15.2
P85/PW15 10	15.1
P80/PW20 1	17.8
P80/PW20 5	17.6
P80/PW20 10	17.9
P75/PW25 1	20.4
P75/PW25 5	20.9
P75/PW25 10	20.7
Wax	NA

Distribution and dispersion of PW in PLA matrix observed by POM

paraffin wax served as a lubricant in the PLA matrix leading to an improved crystallinity which can be observed on the lower cold crystallization temperature compared to neat PLA. This increase in the degree of crystallinity of PLA in the PLA/PW blends was due to the nucleating effect of the paraffin wax phase on the PLA matrix. Conceivably, the molecular mobility and crystallinity of the blends strongly depend on the paraffin wax content and its distribution in the PLA matrix. As the temperature exceeded the melting temperature of paraffin wax, the intramolecular interactions of the paraffin wax collapsed and the low molecular weight chains of paraffin wax began to disentangle and rearrange in the PLA matrix,[22], eventually contributing to the change in crystallinity of the PLA in the PLA/PW composites.

From the DSC curves, it can be seen that there are two melting temperatures. This indicates that PLA and paraffin wax are immiscible. Additionally, the glass transition temperature of PLA and the melting temperature of paraffin wax are 56.2°C and 56.8°C; thus, they overlap one another. For this peak, the one-minute mixing blends acquired higher enthalpy than the five- and ten-minute mixing blends, thus demonstrating that the paraffin wax was not well mixed in the PLA matrix. As the content of the paraffin wax increased, this peak was even more significant.

The dispersion of the paraffin wax in the PLA matrix was slightly affected by the mixing time. With a higher content of paraffin wax, the paraffin wax percentage could be increased, as shown in **Figure 2**. Since a material such as PLA takes a longer time to crystalize, the POM image of neat PLA showed only a few crystals, as can be seen in **Figure 3 (a)**. The nucleating effect caused by the paraffin wax introduced a large number of crystals into the PLA matrix. Moreover, the longer mixing time and greater shear force yielded a better distribution of the paraffin wax, as shown in **Figure 3 (b–d)**.

Figure 2: The Dispersion of (a) 15%, (b) 20%, and (c) 25% Paraffin Wax in the PLA Matrix

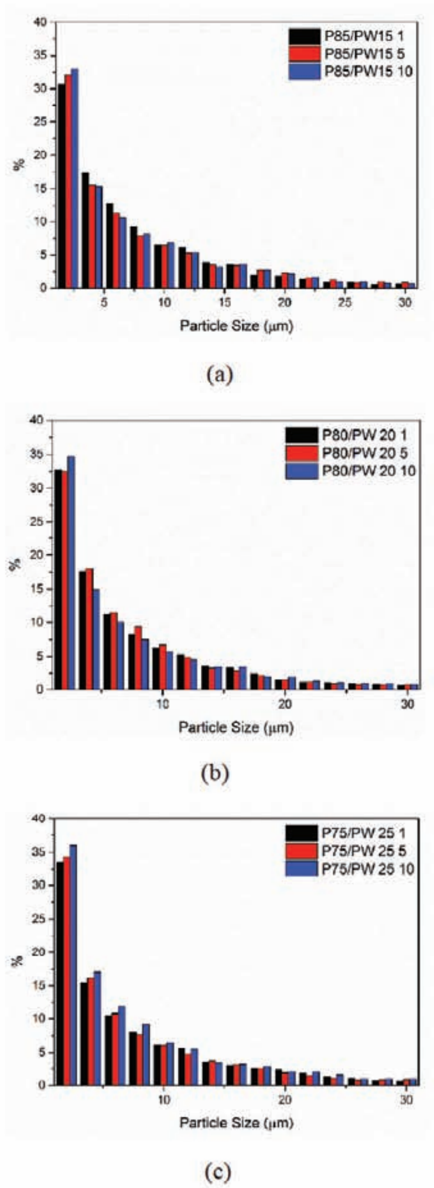
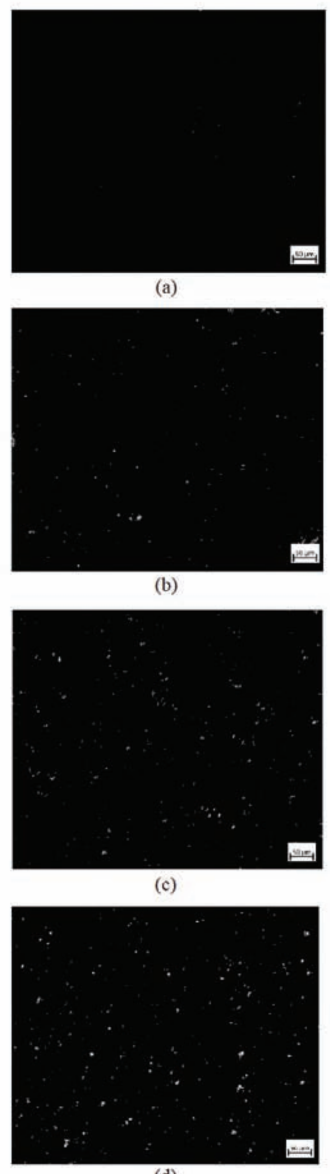


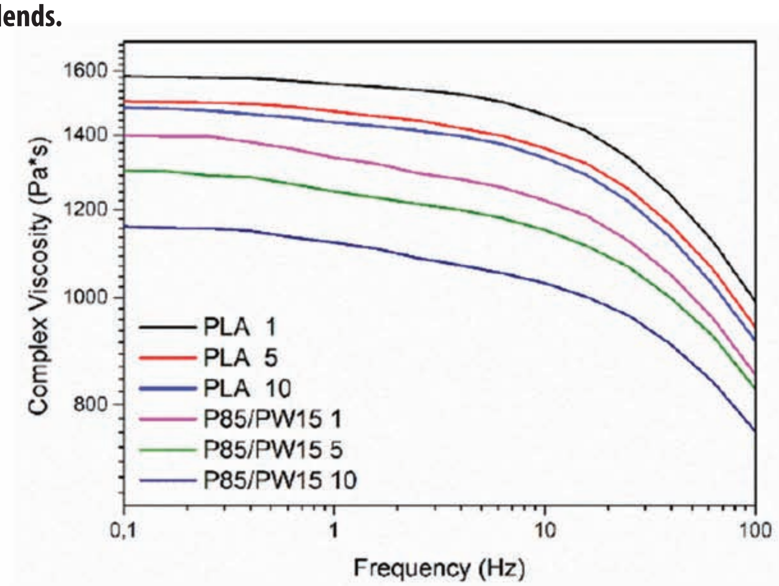
Figure 3: The Distribution of 15% Paraffin Wax in the PLA Matrix at (a) One mMinute, (b) Five Minutes, and (c) Ten Minutes



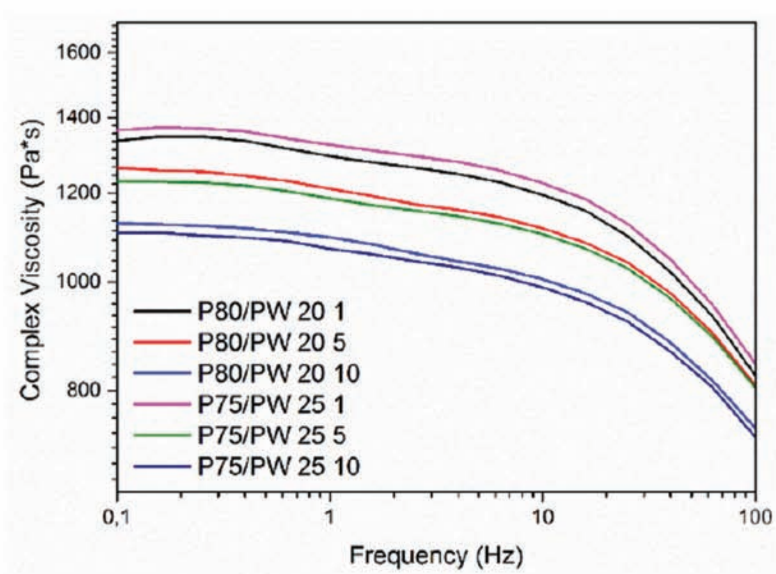
Rheological Properties

Under shear stress, paraffin wax lowers the viscosity of molten polymer composites as shown in **Figure 4**. As is well known, PLA is very sensitive to high temperatures. Thus, longer processing times during PLA compounding caused PLA to undergo severe thermal degradation and chain scission, leading to a lower molecular weight and broadening the molecular weight distribution curve[23, 24]. Therefore, as expected, the ten-minute processing curves exhibited the lowest complex viscosities in each group. In addition, when paraffin wax was added to the polymer matrix, a decrease in complex viscosity values was observed. Furthermore, since paraffin wax acted as a lubricant in the polymer matrix, it is expected that the addition of paraffin wax will further improve the fluidity and processability of the blend as compared to neat PLA.

Figure 4: Complex Viscosity (η*) Verses Frequency of Neat PLA and PLA/PW Blends.



(a)



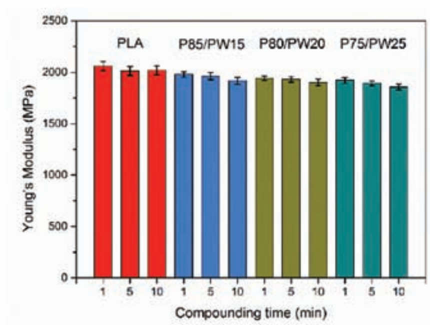
(b)

Mechanical Properties of PLA Blends

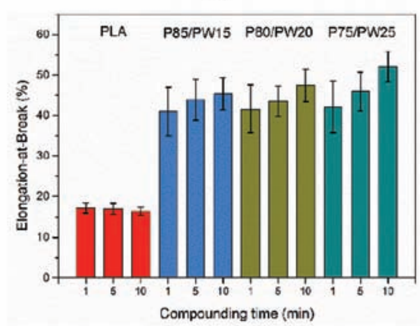
Figure 5 plots the Young's modulus, tensile strength, ductility (elongation-at-break), and toughness (area underneath the stress vs. strain curve) of neat PLA and the blends obtained through tensile tests. The incorporation of paraffin wax exhibited dramatic improvements in ductility and toughness compared to neat PLA. This is due to plasticizer and lubricating effect of the paraffin wax. The Young's modulus, ductility and toughness of neat PLA slightly decreased with the longer compounding time, however, the blends showed different tendency. The elongation at break and the toughness of the blends were increased with the increasing compounding time. This is because the agglomerated paraffin wax disperse more uniformly in PLA matrix as well as lower the standard deviation.

Conclusion

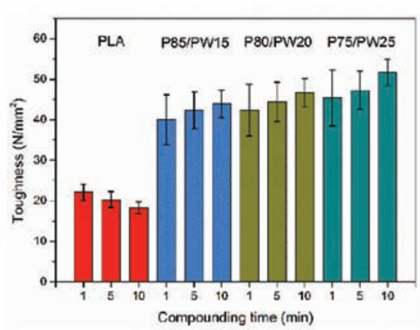
Figure 5: (a) Young's Modulus, (b) Elongation-at-Break and (c) Toughness of Neat PLA and PLA/PW Blends



(a)



(b)



(c)

This study has developed and investigated PLA/PW blends and compared with mechanical properties of micro tensile specimens by injection molding process. The key that greatly improved ductility and toughness under tensile loading is the incorporation of percentage of paraffin wax in PLA/PW composites. Paraffin wax also served as nucleating agent, plasticizer and lubrication in PLA matrix, increasing the crystallinity, ductility, toughness and lowering the complex viscosity. From experimental results, the distribution of the secondary phase material in polymeric matrix can be improved by longer compounding time.

Acknowledgements

The authors would like to acknowledge the support of the colleagues at the Leibniz Institute for Polymer Research, Dresden, Germany, Dr. Andreas Leuteritz, Martin Zimmermann, Yvonne Spörer, Pascal Pöhlmann as well as the Ministry of Science and Technology (MOST) of Taiwan and DAAD for financial support.

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Moldex3D Announced as SPE Preferred Partner

The Society of Plastics Engineers (SPE) announced CoreTech System Co., Ltd. (Moldex3D) as an SPE Preferred Partner on October 1st. An SPE Preferred Partner is a converter, manufacturer, solutions provider or product distributor that has been recognized by SPE for demonstrated leadership and innovation in the plastics industry. Their products and services are valuable to SPE's members.

"We are excited about adding a Preferred Partner that offers plastic injection molding simulation and provides advanced technologies and solutions for industrial demands," said Michael Greskiewicz, SPE's Director, Sales & Advertising. "With Moldex3D's participation in our Preferred Partner program, we're looking forward to continued growth of this program for our members."

"We are very honored to be named as an SPE Preferred Partner", said Dr. Rong-Yeu Chang, Moldex3D CEO and a Fellow of SPE, "Providing global customers with advanced and innovative technologies and services has always been Moldex3D's mission. SPE's recognition certainly gives us more momentum to assist industries to level up their competitiveness in the ever-changing global market."

Founded in 1995, Moldex3D has been dedicated to developing the analysis technology with true simulation and accurate prediction capabilities for plastic molding industries. Moldex3D has brought perfect match between prediction and end-result before real manufacturing, helping enterprises reduce painstaking trial-and-error, shorten time-to-market, and maximize product return on investment (ROI).

The accuracy and usability of Moldex3D enable it to obtain a high market share in Europe, America, and Asia. Moldex3D is also elected as the key molding simulation core by top CAD/CAE/CAM software including Sie-

mens NX, PTC Creo, MSC DigimatRP, and Cimatron. Moreover, Moldex3D has received numerous recognitions such as "James L. White Innovation" from International Polymer Processing (PPS) in 2015, Taiwan Excellence Award in 2016 and the Aoki Katashi Innovation Award in 2019.

Moldex3D plays a pioneering role in plastics simulation solutions around the world, and still strives hard in helping industries realize smart molding and Digital Twin. The idea of Digital Twin has been in Moldex3D's development DNA for a long time. Moldex3D has incorporated a lot of advanced material models and process details in the software to close the gap between physical world and virtual simulation. With the niche technology provided by Moldex3D, enterprises can take on the trend of Industry 4.0 and achieve a higher level of smart manufacturing.

About SPE

SPE-Inspiring Plastics Professionals is 84 countries and 22,500+ members strong. SPE unites plastics professionals worldwide–helping them succeed and strengthening their skills through networking, events, training, and knowledge sharing. No matter where you work in the plastics industry value chain-whether you're a scientist, engineer, technical personnel or a senior executive-nor what your background is, education, gender, culture or age-SPE is here to serve you. Web: www.4spe.org Phone: +1.203.740.5400.

About CoreTech System (Moldex3D)

CoreTech System Co., Ltd. (Moldex3D) has been providing the professional CAE analysis solution "Moldex" series for the plastic injection molding industry since 1995, and the current product "Moldex3D" is marketed worldwide. Committed to providing advanced technologies and solutions to meet industrial demands, CoreTech System has extended its sales and service network to provide local, immediate, and professional service. CoreTech System presents innovative technology, which helps customers troubleshoot problems from product design to development, optimize design patterns, shorten time-to-market, and maximize product return on investment (ROI). More information can be found at www.moldex3d.com.

October 1, 2020

Respectfully Submitted by Secretary Jeremy Dworshak

Welcome & Opening Remarks – Rick Puglielli, Division Chair

Chair Rick Puglielli called the meeting to order at 9:00 AM EST and welcomed all attendees to the Fall 2020 IMD Board Meeting. Secretary Jeremy Dworshak called roll at 9:15 AM (EDT).

Roll Call – Jeremy Dworshak, Secretary

Present: Adam Kramschuster, Alex Beaumont, Amanda Nicholson, Angela Rodenburgh, Bradley Johnson, Chad Ulven, David Kusuma, David Okonski, Edwin Tam, Hoa Pham, Jeremy Dworshak, Joseph Lawrence, Lynzie Nebel, Peter Grelle, Ray McKee, Rick Puglielli, Srikanth Pilla, Susan Montgomery, Tom Turng, Tom Giovannetti, Vikram Bhargava, Sue Wojnicki and John Ratzlaf.

Absent were: Jim Wenskus, Erik Foltz, Kishor Mehta, Larry Geist, Saeed Farahani, Sriraj Patel,

Motion: Previous minutes approved by Peter Grelle, and seconded

Financial Report – Ray McKee, Treasurer of IMD

Ray McKee presented the financial report and mentioned that there was a balance of $46,044.00 remaining in the account. Ray will send out updated financial spreadsheet after the meeting. There is a $4,630 non-refundable downpayment still in-play for a 2021 conference in Corporate College, OH.

Chair Elect for 2021

David Okonski noted that he is unable to be chair for 2021. David set a motion to have Lawrence chair effective July 1, 2021 and then David Okonski will chair effective July 1, 2022.

Motion: Motion seconded. Motion passed.

Technical Director Report/TPC update – Pete Grelle, Technical Director

ANTEC 2021 update/IMTech 2021 updates and TOPCON activities review

Pete Grelle presented a PPT of the IMD technical program. NPE will be held in May 2021 in Orlando. ANTEC will be held in March 2021 in Denver. Penn State conference will be held next in June 2022. (2021 will be skipped - due to NPE year).

Susan Montgomery update everyone on the IMD virtually conference. A17 total attendees. Revenue of $1,900 to IMD from Headquarters from sharing (50:50) event revenue.

Improvement ideas:

Narrowing conference scope, identify key-notes earlier, find sponsors on theme, presenters could not be a part of Q&A, double-check conflicting conferences, conference fee optimization, and lack of IMD board member support. Sue Wojnicki discussed Headquarter's learning on holding virtual conferences:

- Revenue is less, yet expenses are also less.
- Allowing for new markets (topics and languages).

ACTION: Susan Montgomery will send out a link to the Cleveland Section's survey results to their membership on upcoming conferences.

ACTION: Angela Rodenburgh and Adam Kramschuster created a marketing ppt for review that includes develop ideas for '*What the IMD does*.' which will be sent after the meeting. Angela will prepare a presentation for Jan 2021 on where the IMD is heading, with regard to marketing.

- **Call for volunteers:** posting contect on social media. Contact Rodenburgh for more information.
- **IMD Newsletter:** no content and minimal direction as to how to move forward.

John Ratzlaff encouraged an IMD Board member to participate in the Plastics for Life.
Joseph Lawrence covered the ANTEC 2021 schedule.

ByLaws Committee Update – David Okonski

David Okonski has no update, it's a work in-progress. Jan 2021, David will have a by-law update for the board.

Board Nominations Update – Hoa Pham

No action needed, officer roles set for 2020-2021

Councilor Report – Edwin Tam

Edwin Tam presented ppt for the council update. Executive Board (EB) communicated goals for the council to take action on. Identify and promote a significant, actionale cause in support of SPE's mission. Establish a forward-looking 'think tank' to identify emerging technologies for creating new programs. Organize SPE content into an accessible resource to generate revenue. Evaluate industry knowledge gaps for programming options to generate revenue. Create effective knowledge sharing and increase engagement and networking.

ACTION: Edwin Tam will provide his ppt presentation to board members.

Other Business – Tom Turng

- IMD has two nominations for SPE Fellow in 2021.
- Jeffrey Jansen is IMD nominate for SPE Fellow.
- Manjusri Misra is nominated for SPE Fellow.

ACTION: Board to reach out to Rich Puglielli with any other in-person options.

Adjournment

Motion to adjurn Peter Grelle) and seconded. Motion passes.

The next meeting will held on January 17th 2020 at the Tupperware headquarters in Orlando, Florida. An agenda will be provided by Rick in early January.

spe

INJECTION MOLDING

Top Reasons to Join SPE and its Injection Molding Division

Networking within the Plastics Industry
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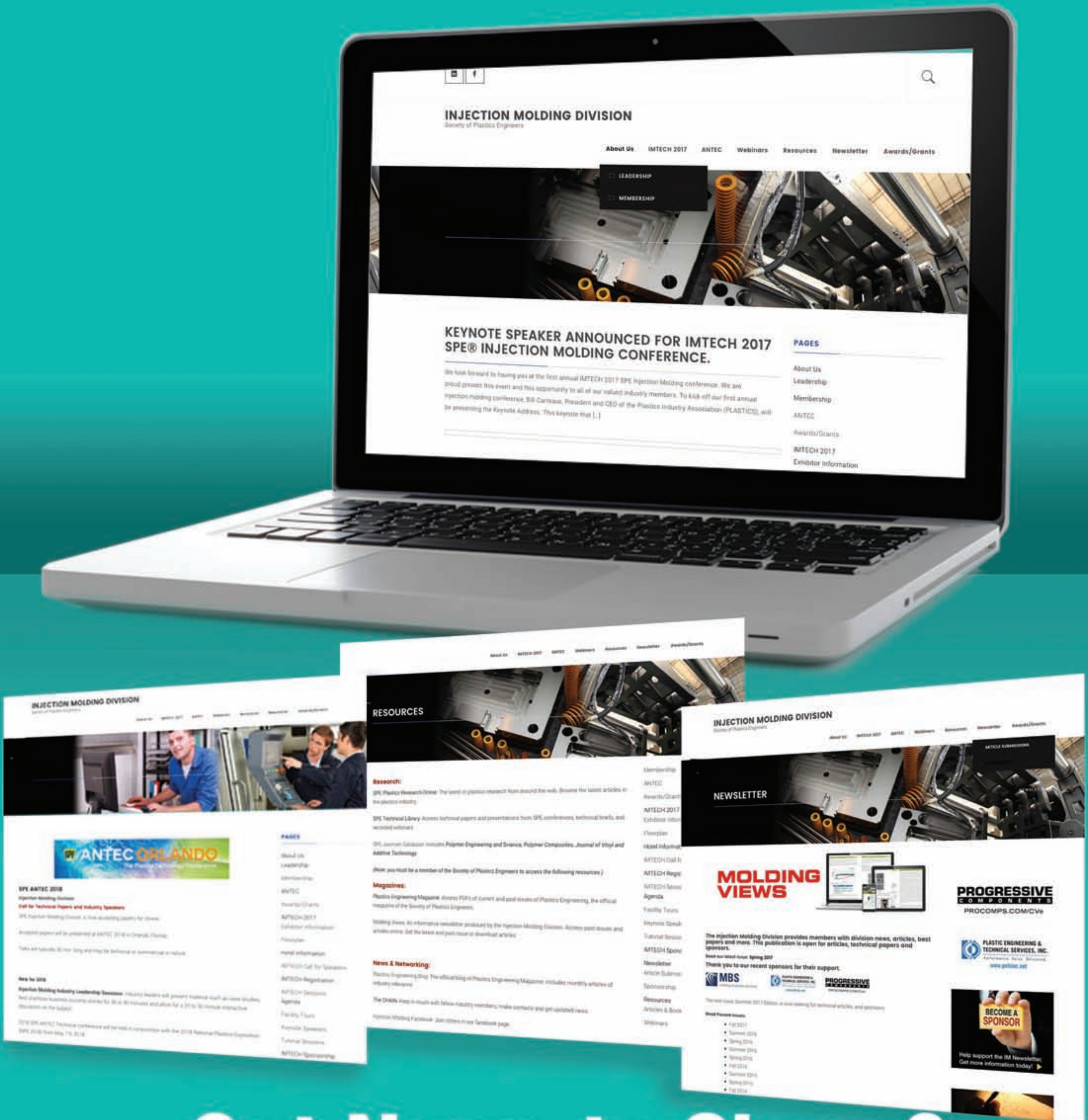

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