Technical Program for GPEC 2006

Plenary Speakers:

-- ***Samantha Phillips Fairchild,*** Director of the Office of Enforcement,
U. S. Environmental Protection Agency (EPA)

-- ***William R. Carteaux,*** President of The Society of the Plastics Industry, Inc. (SPI)

Bio-based and Biodegradable Materials:

1B. **Characterization of Environmentally Friendly Polymers: Amylopectin and Its Blends**
Mohammad O. Melibari, M.Sc., Saudi Arabian Oil Company

2B. **The Rheology and Degradation of Renewable Resource Polymers**
Graham M. Harrison, Clemson University

3B. **Combined Effects of Crosslinkers, Glycerol and Processing Temperature on Properties of Soy Protein Based Plastics**
Brian E. Ralston, N. Wochner and Tim A. Osswald, Univ. of Wisconsin-Madison

4B**. EcoflexT Meets Renewable Materials**
Keith A. Edwards, BASF Corporation

5B. **Bioplastics in Electronic Products**
Markku T. Hieno and Antti O. Helminen, D.Sc. (Tech.) Nokia Research Center

6B. **Biodegradation of Compostable Plastics in Cow-manure Compost Environment**
Joseph P. Greene, PhD, California State University

8B. **Comparing the Degradability of Commercially Available Biodegradable Packages In Composting and Ambient Exposure Conditions**
Rafael Auras, Gaurav Kale, Sher Paul Singh, Michigan State University

9B. **Considerations Affecting Biodegradability of PVC**
Richard F. Grossman, PhD, RFG Consultants
John E. Schleicher, Jr. and Lorna D'Alessio, Ultraflex Systems

13B**. Effects of Bamboo and Kenaf Fibers on the Mechanical Properties of Lightweight Porous Composites**
Shinichi Shibata, Takuya Kamiyama and Isao Fukumoto, University of the Ryukyus, Nishihara, Okinawa Japan

15B. **Thermoformed Packaging from Soy Protein Isolate Resin**
Dr. Lou Reifschneider, Illinois State University

16B. **Evaluation of Soy Protein Isolate/Soy Hydrolysate Evaluation of Soy Protein Isolate/Soy Hydrolysate**
Dr. David Grewell, Maria Vlad, Jay-Lin Jane, Perminus Mungara, Iowa State U.

17B. **Metabolix's Natural Plastics: Property Space and Processing Capabilities**
Robert Whitehouse, Metabolix Inc.

18B**. Synthesis and Characterization of Nano-engineered Biochemical Decontaminants**
Brian Ray, Chih-ang Chang, Dilip Paul, Christopher Ibeh, Pittsburg State Univ.

19B. **Some Recent Advances in Thermoplastically Processable Biodegradable Starch, Polyvinyl Alcohol- And Polyactide-Based Polymer Blends**
Graham J. Whitchurch and Terence A. Cooper, Stanelco plc.

20B. **The Effect of Fiber Surface Treatment on Laminated Biocomposites from Poly (Lactic Acid) (PLA) and Natural Fibers**
Manjusri Misra, Masud S. Huda, Lawrence T. Drzal, Amar K. Mohanty, Michigan State University

Automotive:

1A. **Automotive Foams and Composites From Renewable Resources**
Ellen C. Lee, Ph.D., Ford Motor Company

2A. **Creation of Vibrant and Long-Lasting Coatings for Light Trucks and Automobiles with Reduced Emissions to the Environment using Paint Film**
Gordon C. Miller, MM&A LLC

6A**. Effect of Regrind on Vibration Welding Strength of Polyolefins**
Ewa Lebert, Dr. Chung Wu, and Susan Kozora, Visteon Corp.

7A. **Advanced Methods for Paint/Coating Removal From Recyclable Substrates**
Lin Zhihong, Ph.D., Applied Chemical Technologies, Inc.

8A. **Overview: Automotive Comfort Technologies supporting Sustainable Environment**
Hameed S. Khan, Rieter Automotive North America Inc.

9A**. Paint removal for TPO substrates**
Bob Egbers, ACI

10A**. Automotive Plastics Opportunities**
Steve Schellenberg, WorldPort Logistics Center/CMC Rail Yard, Dayton, TX

Electronics:

E1. **Recycled Electronic Housings Mixed ABS Material and Flame Retardant Identification Using Near-IR and Mechanical Testing**
Mike W Dattner, Univ. of Wisconsin, Polymer Eng. Center

E2. **Recycling Mixed Plastics from End-Of-Life Electronics**
Rakesh Gupta, West Virginia University, and Adam Al-Mulla, Kuwait Univ.

E3. **Using Portable XRF Tools to Meet EU's Restriction of Hazard Substances/Waste Electrical and Electronic Equipment (RoHS/WEEE) Requirements**
Jim Martin, Innov-X Systems, Woburn, MA

E4. **Large Scale Co-combustion of Plastics from the End-of-Life Electrical and Electronic Equipment at the Wuerzburg Municipal Solid Waste Energy Recovery Plant (MHKW)**
Dr. Michael M. Fisher, American Plastics Council,
Britta Bergfeldt, ITC, Hans Dresch, ZvAWS, Bogdan Dima, MHKW,
Werner Gruettner, ZvAWS, Kai Kramer, Electrocycling, Theo Lehner, Boliden,
Frank E. Mark, PlasticsEurope/Dow Europe, Juergen Vehlow, ITC

E5. **RoHS Challenges and Restricted Substances Compliance Solutions**
George J. Fechtmann, PE, Underwriters Laboratories (UL), New York

Reclamation and Supply:

RS1. **Technological Advancements in Separation and Sorting Technology for Recycled Plastics**
Peter Mayer, S+S Separation and Sorting Technology GmbH

RS2. **Carpet Reclamation**
Bob Peoples, PhD, Carpet & Rug Institute

RS3. **Quality Assurance Testing Protocol for Post Consumer Resins (PCR) in California**
Joseph P. Greene, Ph.D., California State University

RS4**. IRD: Infrared Rotary Drum Drying**
John W. Doub, Jr., Novatech

RS5. **Recycling of Fibers and Non-Wovens**
Barry B Hunter, American Starlinger-Sahm, Inc.

RS6. **It's Not Easy Being Green, Especially When It's Brown! Diapers: The Ongoing Recycling Opportunity**
Keith Bell, Recycling Programs, Inc. (RPI)

RS9. **Success of Closed-Looped Plastic Recycling Systems**
Anthony S. Georges, VP, AMUT & ARIOSTEA N.A.

RS10. **A Case Study of a PVC Pipe Recycling Program**
Craig Fisher, P.E., Uni-Bell PVC Pipe Association
and Preston Creelman, P.E., Royal Pipe Systems

RS11. **Who Says PVC Can't Be Recycled?**
Craig Fisher, P.E., Uni-Bell PVC Pipe Association

RS12. **Closed Loop Recycling**
Daniel Schrager, NextLife Recycling

RS13. **The Dilemmas of Plastic Wastes in a Developing Economy: Proposals for A Sustainable Management Approach for Ghana**
Julius N. Fobil, College of Health Sciences, University of Ghana,
and Jonathan N. Hogarh, Dept. of Theo, and Applied Bio.
Kwame Nkrumah Univ. of Science & Technology, Kumasi, Ghana

RS14**. New Technological Solutions for Reducing Landfill Waste**
M.A. McMillan, T. Black, M.B. Johnston and T.A. Cooper
Environmental Technology Associates Inc. Kula, Hawaii

RS15. **Recycling Processes which Enable Economical Conversion, Including that of Difficult to Handle Materials,**
Mike Horrocks, Erema North America, Inc.

RS16. **Study on the Construction of Flexible Road Using Plastic Coated Aggregate**
Dr. R. Vasudevan and S. Rajasekaran
Thiagarajar College of Engineering, Madurai, India

Regulatory: Laws/Safety/Legislation:

REG1. **Current Issues & Regulatory Status Concerning Flame Retardants**
Susan D. Landry and Raymond B. Dawson, Albemarle Corporation

REG2. **Challenges faced by thermoplastic suppliers due to WEEE and RoHS directives**
Nancy Concepcion, Spartech Plastics

REG3**. Emission Modeling of Styrene from Vinyl Ester Resin: Effect of Styrene Percentage, Temp., and Resin Depth**
Dr. Uday Vaidya, Univ. of Alabama -Birmingham, Chad A. Ulven,
North Dakota State Univ., James M. Sands, John J. La Scala, Joshua A. Orlicki,
US Army Research Lab, Giuseppe R. Palmese, Drexel Univ.

REG4. **The Health and Environmental Effects of the Production, Use, and Disposal of Polyvinylchloride**
Nick Newman, Tim Osswald, Ryan Hertel, University of Wisconsin-Madison

REG5. **Use of Plastics With Care: Code For India**
Dr. Mrs. N. Rajalakshmi, University of Madras, India

Marketing and Business: Recycling/Sustainability/ELV

MB1. **Methyltins: Sustainable Stabilizers for PVC**
Dr. Richard W. Johnson, Michael B. Clark, Rohm & Haas Co.

MB3. **Branding is One of a Company's Most Important Assets**
John R Kowalski, Cascade Engineering

MB4. **Design of Business Chain for Development and Sustainable Growth of PET Recycling In India**
Clement Ambros, Reliance Industries Ltd.

MB5. **PVC/Natural Fiber Composites: Back to the Future for Fun and Profit!**
Edward Schut, CreaFill Fibers

Student Poster to Date:

1. **Recycled Electronic Housings Mixed ABS Material and Flame Retardant Identification Using Near-IR and Mechanical Testing**
   Mike W Dattner, Univ. of Wisconsin, Polymer Eng. Center

2. **Development of a Respirometric System to Test Biopolymer Degradation**
   Thitisilp Kijchavengkul, Rafael Aura, Maria Rubino, School of Packaging, Michigan State Univ., Mathieu Ngouajio, R. Thomas Fernandez, Dept. of Horticulture, Michigan State University

3. **The Effects of Foaming Temperature, and Time on the Tensile Strength, Size and Morphology of Microcellular Foam**
   Napawan Kositruangchai (Na), Graduate Research Assistant, School of Packaging, Michigan State University

4. **Design, Synthesis and Characterization of Nano-Engineered Biochemical Decontaminants**
   Brian Ray, Chih-ang Chang, Dilip Paul, Christopher Ibeh, Center for Nanocomposites and Multifunctional Material, Pittsburg State University

GPEC 2006 Paper Abstract #1B

Title: Characterization Of Environmentally Friendly Polymers: Amylopectin And Its Blends

Authors: Mohammad O. Melibari and Zeki Y.Al-Saigh, Saudi Arabian Oil Company

ABSTRACT

Biodegradable polymers are desirable for a variety of applications, such as in packaging, agriculture, and medicine. Its biological degradation by microorganisms accelerated the interest in biodegradable polymers during the last decades. Within this group of innovative environmentally friendly biodegradable polymers, starch or Amylpectin plays a predominant role, due to their potential biodegradability. This research was attempted to characterize Amylopectin to obtain its physio-chemical properties. In addition, characterizations were extended to include blends of Amylopectin and biodegradable diluents. Blends of Amylopectin with biodegradable diluents including Polycaprolactone, Poly(DL-lactide-co-glycolide), and Poly(3-hydroxybutyric acid) were prepared. The physical properties and the thermodynamic characteristics of these blends were investigated using the Inverse Gas Chromatography (IGC) method. This was conducted over a range of temperatures until a complete set of data was obtained. Nineteen solutes with different chemical natures were selected in this study. Solutes, including a series of alkanes, acetates, alcohols, diethylamine, formic acid, and water, were injected into Amylopectin and its blends chromatographic columns. The retention times of solutes were measured for each solute. Slopes and heats of mixing of solutes with pure Amylopectin and its blends were calculated. All columns except the 50-50 Amylopectin-Polycaprolactone column showed a minimum of two regions in the retention diagram. These regions were identified as crystalline and amorphous regions. A third region was identified above 200^oC as the polymer started to decompose. However, for 50-50 Amylopectin-Polycaprolactone column, a straight line was observed in most solutes due to the lack of data at higher temperatures. All columns except for some solutes of 50-50 Amylopectin-Polycaprolactone column showed a glass transition temperature (T_g) that has a range from 90^oC to 140^oC. The T_g is the first minimum temperature in the curvature that can be identified. In addition, all columns except for some solutes of 50-50 Amylopectin-Polycaprolactone column showed maxima of the curvature. These maxima were identified as the melting point (T_m) of the polymers, which ranged from 100^oC to 170^oC. By blending Amylopectin with other polymers, the T_m was decreased or a depression phenomenon was formed and this is due to less melting amorphous. The dispersive surface energy value of the 100% Amylopectin column was 0.07 mJ/m^2 at 200^oC. The dispersive surface energy values of the 75-25 Amylopectin-Polycaprolactone column were ranged from 18.59 mJ/m^2 at 170^oC to 10.27 mJ/m^2 at 260^oC. In addition, the dispersive surface energy values of the 50-50 Amylopectin-Poly(DL-lactide-co-glycolide) column were ranged from 46.30 mJ/m^2 at 160^oC to 39.03 mJ/m^2 at 180^oC, while, the dispersive surface energy values of the 50-50 Amylopectin-Poly(3-hydroxybutyric acid) column were ranged from 55.46 mJ/m^2 at 160^oC to 1.31 mJ/m^2 at 200^oC. Therefore, blending Amylopectin with other polymer will increase its mechanical properties and thus, the surface energy.

GPEC 2006 Paper Abstract #2B

Title: The Rheology and Degradation of Renewable Resource Polymers

Authors: James Eickhoff and Graham M. Harrison, Department of Chemical and Biomolecular Engineering and Center for Advanced Engineering Fibers and Films, 205 Earle Hall, Clemson University, Clemson, SC 29634-0909

ABSTRACT

In recent years there has been a growing interest in the development of alternatives to petroleum based products. Bio-derived polymers have been shown to demonstrate similar mechanical properties as well as superior degradation properties to existing commercial products. One family of biodegradable polyesters of particular interest are polyhydroxyalkanoate (PHA) co-polymers. In this work, we investigate the flow behavior of both a pure PHA co-polymer, namely poly (3-hydroxybutyrate-co-3-hydroxyhexanoate), and blends of this PHA with PLA. We report on the shear and extensional flow behavior of these materials. Extensional tests of the materials are performed over a range of temperatures (155°C to 175°C) and strain rates (0.01 to 10 s^{-1}) typically encountered in processing applications.

Transient dynamic rheological experiments, coupled with GPC analysis, were employed to determine the degradation kinetics of the materials. A random chain scission model was used to determine the degradation rate constant over a range of temperatures. Results will be presented for both the pure PHA samples as well as the PLA/PHA blends.

GPEC 2006 Paper Abstract #3B

Title: Combined Effects of Crosslinkers, Glycerol and Processing Temperature on Properties of Soy Protein Based Plastics

Authors: B.E. Ralston, N. Wochner and T.A. Osswald, Polymer Engineering Center
Department of Mechanical Engineering, University of Wisconsin-Madison, 1513 University Ave., Madison, WI 53706

ABSTRACT

In the past decade research on plastics derived from soy protein has intensified, yielding promising results. These alternative materials come from renewable and sustainable feedstock, unlike conventional plastics made from petroleum. Soy protein plastics have the additional benefits of being optionally biodegradable and biocompatible, making them strong candidates for medical devices, drug delivery and implants. Production of parts made from soy protein plastic using conventional methods (injection molding, extrusion) has met with some success. However, mechanical properties and water resistance of these materials still fall short of their petroleum based counterparts. This paper explores the properties of compression molded soy protein parts made with several crosslinkers used in conjunction with glycerol as a plasticizer. While the effects of glycerol and some crosslinkers have been explored in isolation, this paper offers the first analysis of their combined impact. The effects of varying amounts of these additives and different processing temperatures on tensile and water absorption properties are quantified and statistical significance is determined. Potential for extrusion and injection molding these formulations is discussed.

GPEC 2006 Paper Abstract #4B

Title: EcoflexT meets Renewable Materials

Author: Keith A. Edwards, Market Manager EcoflexT Biodegradable Plastics, BASF Corporation

ABSTRACT

EcoflexT Fully Biodegradable Plastic is a unique co-polyester based polymer with excellent physical properties for blown film, cast film and extrusion coating applications. Commercialized in 1998 and brought to the North American market in 2003, Ecoflex is used in compostable bags, agriculture mulch film, flexible packaging for foods and as a modifier for renewable based products. Ecoflex is the ultimate enabler for many sustainable products based on annually renewable feedstocks, such as polylactic acid, starch, cellulose, lignin and other materials. BASF is introducing EcovioT, a new line of biobased and biodegradable polymers based on the chemistry of Ecoflex and renewable feedstocks. The physical properties of Ecovio make it highly suitable for flexible films, sheeting, blow molded or injection molded products. Through Ecovio, packaging designers can now utilize materials that are biodegradable, 45-60% bio-based and have the necessary physical properties to perform in today's demanding applications.

GPEC 2006 Paper Abstract #5B

Title: Bioplastics in Electronic Plastics

Authors: Antti O. Helminen, Kenichi Hashizume and Markku Heino, Nokia Research Center, P.O. Box 407, FI-00045 NOKIA GROUP, Finland, Nokia Research Center, Tokyo.

ABSTRACT

Bioplastics have entered the market especially in the agricultural and sales packaging applications. Due to the material development and increased production they provide an attractive alternative to conventional petroleum-based plastics. Recently first signs of bioplastics emerging into the consumer electronics have been seen from the aspect of carbon neutralized concept, especially in Japan. From the view point of consumer electronics the driver for using bioplastics is in using renewable resources instead of non-renewable fossil fuels. This contributes to CO2 neutral products and lessens our dependence on fossil fuels as an economy. Compostability as an end-of-life practice is certainly an advantage for products with relatively short life time such as sales packages, but in consumer electronics the separation of the compostable parts is not very likely to happen with current recycling systems.

Plastics currently compose of a large percentage of the mobile devices, where their main function is to protect the core electronics. Engineering thermoplastic such as PC, PC/ABS, ABS, PA12 and glass fiber reinforced plastics are used in cover and other structural parts and transparent plastics such as PMMA in display windows. The biggest challenges in using bio-based plastics are in their heat resistance and impact strength properties. Material used for mobile device needs not only to fulfill mechanical and structural requirements but look good as well. With conventional plastics attractive appearance has been obtained mainly by applying different decoration techniques such as painting, in-mould-labeling or printing. However, there is only very limited experience on applying these processes to bioplastics and their effect on the environmental performance is not well assessed.

Ensuring that overall environmental sustainability criteria are met and way of communicating this to the customers are challenging issues. Currently everything with a prefix ‘bio’ is considered positive, but might lose its attractiveness if content will be found misleading. The terminology related to bioplastics is unclear and can raise confusion among consumers. Marking or labeling systems exist in different continents for compostable materials fulfilling the compostability standards for packages (such as EN13432 in Europe), but for bio-based materials standardization is not finalized.

GPEC 2006 Paper Abstract #6B

Title: Biodegradation of Compostable Plastics in Cow-manure Compost Environment

Author: Joseph P. Greene, Ph.D., Professor, Department of Mechanical Engineering Mechatronic Engineering and Manufacturing Technology California State University, Chico, Chico, CA 95929-0789

ABSTRACT

Several compostable plastics which meet the ASTM D6400 standards for compostable degradation were tested in a cow manure based compost environment. The plastic materials are all commercially available plastics that are made from either corn, polylactic acid, potato, or sugar cane. The control materials included cellulose filter paper, Avicell microcellulose, and Kraft paper. The carbon dioxide and ammonia levels were measured at bi-weekly intervals as well as the temperature and compost maturity index at the compost sites. The testing in commercial compost facilities allows the compostable plastics to be exposed to active compost, which should have a higher degree of enzyme activity, and higher temperatures that mimic the most likely conditions that the compostable plastics will be exposed to in commercial operations. All of the materials were fully degraded in 70 days. The moisture content of the compost was approximately 55% over the duration of the experiment. The temperature of the outside air ranged from 18°C to 42°C. The temperature of the compost ranged from 48°C to 64°C during the duration of the experiment.

GPEC 2006 Paper Abstract #8B

Title: Comparing the degradability of commercially available biodegradable packages in composting and ambient exposure conditions

Authors: Gaurav Kale, Rafael Auras, Sher Paul Singh, School of Packaging, Michigan State University, East Lansing, MI 48824-1223

ABSTRACT

The adoption of biodegradable polymeric materials is increasing in food and consumer good packaging applications due to the concerns of disposing of petroleum based polymers. Currently Poly (lactide) (PLA) polymers are the biggest commercially available bio-based polymeric packaging materials. Life cycle analyses show that PLA polymers consume around two times less energy than conventional petroleum based polymers. As the main concern in regards to PLA adoption is environmental, there is a need to address the degradability and environmental performance of these biodegradable packages. This study focuses on comparing the degradability of two commercially available biodegradable packages, a PLA bottle composed of 96% L-lactide and 4% D-lactide with bluetone additive and a PLA deli container composed of 94% L-lactide and 6% D-lactide in composting and ambient environments. Both composting and ambient exposure degradability mechanisms were carried out in real conditions governed by weather, microbial growth and pH of compost, distinct from the simulated ones in which the parameters are controlled. The packages were placed in duplicates in the compost pile and similarly they were exposed in duplicates to the ambient environment; and they were taken out on days 1, 2, 4, 6, 9, 15 and 30 for analyzing their property changes. When taking out the packages these were inspected for shape, texture, color changes and material breakdown. The molecular weight (MW) and the glass transition (T_g), melting (T_m) and decomposition (T_D) temperatures were monitored to assess the changes in the packages' physical properties. The MW was assessed by gel permeation chromatography (GPC), the T_g and T_m by differential scanning calorimetry (DSC), and the T_D by thermogravimetric analysis.

The degradation of packages subjected to composting conditions was observed right from the first day in correlation to their dimensions, shape, thickness and color changes. The deli container was completely composted on the 30th day, while the bottle still had some residues. Molecular weight of bottles was reduced by 98.5% on the 30th day of being in the compost and that of deli container was reduced by 97.4% on the 15th day. No such changes were observed for both packages subjected to ambient exposure conditions. When exposed to ambient conditions, bottles molecular weight was reduced by 4.2% and deli containers' was increased by 2.4%. DSC analysis show that bottles exposed to compost conditions showed a T_g reduction of 46% and a T_m reduction of 30% of the initial values on the 30th day. Deli containers showed a reduction of T_g of 12% and 3% of T_m respectively on the 15th day. In the case of the packages subjected to ambient exposure conditions, bottles showed an increase in T_g of 1.2% and a reduction of 0.7% in T_m; deli containers showed an increase of 1.2% in T_g and a 0.5% reduction in T_m. A reduction of the decomposition temperature of the samples exposed to compost conditions was also observed. First order degradation kinetics were observed for both packages subjected to composting conditions. It was verified that the degradability of PLA is mainly affected by the L-lactide content, initial crystallinity and degradation conditions or parameters.

In summary, a distinction between two degradation processes, compost and ambient, and for distinct packages was addressed. Thus a novel technique was used to identify and compare the degradation of two complete packages in two different real environments.

GPEC 2006 Paper Abstract #9B

Title: Considerations Affecting Biodegradability of PVC

Authors: Richard F. Grossman, PhD, RFG Consultants, John E. Schleicher, Jr. and Lorna D'Alessio, Ultraflex Systems

ABSTRACT

Carbon-chlorine bonds are not a barrier to biodegradation. Bacteria and fungi exist that can, for example, metabolize PCBs and pentachlorophenol. The difficulty with polymers of all types is molecular weight. Biodegradation of PVC film and sheet under landfill conditions requires an additive package that, under such conditions, initiates degradation and directs its course to chain scission rather than crosslinking. A class of such additives has been found. Since food metabolism occurs outside the micro-organism, it is further necessary to direct the sensory capability of bacteria and fungi towards the article by including migratory components that will be recognized as nutrients. A discussion of useful fillers and plasticizers is presented as well as the degradation path envisioned.

GPEC 2006 Paper Abstract #13B

Title: Effects of Bamboo and Kenaf Fibers on the Mechanical Properties of Lightweight Porous Composites

Authors: Shinichi SHIBATA, Takuya KAMIYAMA and Isao FUKUMOTO
Affiliation: Department of Mechanical Systems Engineering, University of the Ryukyus, Nishihara, OKINAWA Japan, Postal code: 903-0213

ABSTRACT

Lightweight laminated composites made from Bamboo, kenaf and polypropylene (PP) fibres were fabricated with a press forming. The effects of number of layers, heating temperature and fiber weight fraction on flexural modulus were investigated. The flexural modulus increased with increasing the number of layers and heating temperature. The increase of number of layer contributed homogeneous PP dispersion in composite board because kenaf layers, which were pressed to each other, prevented PP fiber from shrinking during heating. The increase of heating temperature contributed better wetting between bamboo, kenaf and PP. These observations were revealed with SEM micro-photographs. Moreover, the flexural modulus difference between experimental and calculation, which was predicted by Cox model, increased with decrease of the bulk density in the composite board and increase of fiber weight fraction. This was attributed that stress transfer efficiency between fibers decrease with decrease of PP layer density per area in the lightweight composites. Thus, the optimized weight fraction which showed maximum flexural modulus in the composite specimen decreased with decrease of bulk density.

GPEC 2006 Paper Abstract #15B

Title: Thermoformed Packaging from Soy Protein Isolate Resin

Author: Dr.Louis Reifschneider, Assistant Professor, Department of Technology,
Illinois State University

ABSTRACT

Prototype thermoforming trials of a soy protein isolate based sheet material are conducted to evaluate the effect of moisture level, draw ratio, plug-assist, and vacuum rates on the forming of cup-shaped containers. The forming behavior of the soy sheet is compared to PVC and PP materials. Cycle time and draw ratio comparisons are made.

GPEC 2006 Paper Abstract #16B

Title: Evaluation of Soy Protein Isolate/Soy Hydrolysate Plastics

Author: Maria Vlad, Jay-lin Jane, Perminus Mungara, David Grewell, Department of Agricultural & Biosystems Engineering, Iowa State University, Iowa Center of Crops Utilization Research, Iowa State University, Iowa, 50011

ABSTRACT

Biodegradable plastics based on soy protein isolate were prepared with soy hydrolysate as a plasticizer via different methods, and the mechanical properties of the samples from the different processing methods were tested and compared. The results indicated that the tensile strength and the elongation at break of the samples with soy hydrolysate were enhanced when the preparation process consisted of extrusion followed by injection molding or compression molding, but no improvement was noticed in the case of the compression molding prior to extrusion.

GPEC 2006 Paper Abstract #17B

Title: Metabolix's Natural Plastics: Property Space and Processing Capabilities

Author: Robert S. Whitehouse, Director of Applications Development, Metabolix Inc.

ABSTRACT

The vision of Metabolix is a sustainable future through biotechnology for plastics, energy and fuels. Founded in 1992, Metabolix, Inc. uses microorganisms to produce natural plastics via fermentation. The company is also working on producing its innovative Natural Plastics directly in non-food crop plants. Metabolix formed a strategic collaboration in November 2004 with Archer Daniels Midland to produce its Natural Plastics commercially via fermentation. The company also has collaborative support from British Petroleum to progress the plant research. In June of 2005, Metabolix received the Presidential Green Chemistry Challenge Award for it development of Natural Plastics.

The key to all new polymers is that they need to offer differentiation from the incumbent materials. Most other biobased or biodegradable polymers are difficult to process, often resulting in higher conversion costs or reduced performance against petroleum based resins. Designed to process on existing equipment, these new biobased, sustainable materials are high performing and versatile, making them appropriate for applications such as injection molded and extruded products, paper coatings, thermoformed items, and film. Metabolix Natural Plastics have good water resistance but will readily biodegrade in hot and cold composting, marine and fresh water, soil and anaerobic environments.

This presentation will review the recent development in material properties and conversion techniques.

GPEC 2006 Paper Abstract #18B

Title: Design, Synthesis and Characterization of Nano-engineered Biochemical Decontaminants

Authors: Brian Ray, Chih-ang Chang, Dilip Paul, Christopher Ibeh, Center for Nanocomposites and Multifunctional Materials [CNCMM], Pittsburg State University, Pittsburg, KS 66762

ABSTRACT

Novel mixed metal oxide nanoparticles involving mesoporous MCM-41, 2.5%Sb-2%Cr-$SrTiO_3$ and 2%Cr-$SrTiO_3$ were synthesized using the sol-gel method, and characterized using surface area and XRD measurements. These mixed metal oxide nanoparticles were then studied using FT-IR and mass spectroscopy to explore their reactivity towards a common organic pollutant, acetaldehyde. It was found that the 2.5%Sb-2%Cr-$SrTiO_3$ and 2%Cr-$SrTiO_3$ surfaces adsorbed acetaldehyde through irreversible mechanisms involving surface hydroxyl groups. Upon exposure to ~15Torr of oxygen but in the absence of anything but minimal ambient light, no change in reaction was recorded indicating the necessity of light as an activating factor for the catalytic properties of these nanoparticles. Upon exposure to the visible spectrum, reactions resulting in acetate species were observed on both samples with some differences. It was generally found that some additional reactivity was afforded by the incorporation of a charge balancing species such as antimony. Significant addition reactivity was observed when the spectrum of incoming light was widened to include wavelengths as low as 300nm. Though the mixed metal oxides nanoparticles were originally conceived for nanocomposites formulation, these preliminary results indicate that they are viable biochemical decontaminates.

GPEC 2006 Paper Abstract #19B

Title: Some Recent Advances in Thermoplastically-Processable Biodegradable Starch, Polyvinyl Alcohol and Polylactide Based Polymer Blends

Authors: Graham J. Whitchurch and Terence A. Cooper, Stanelco plc., and Adept Polymer, Ltd, Manchester, UK

ABSTRACT

Advances in polyvinyl alcohol (PVOH) formulating and processing technology have enabled a family of water-soluble, biodegradable and non-toxic PVOH-based thermoplastic materials to be produced which can be commercially melt-processed without undergoing thermal or shear degradation. PVOH product/property combinations are tailored and controlled by selection of the PVOH polymers used, formulating methods and processing parameters. Product types are now available with controllable water-dissolution temperatures ranging from 5-80°C. These can be employed for production of film, sheet, fibers, foams, tubing, profile extrusions and moldings by using processes including film blowing, sheet casting, thermoforming, extrusion, coextrusion and injection- and blow-molding.

Combination of these PVOH-based materials with recently developed engineered thermoplastic and water-soluble starches now enables economical water-soluble blends to be produced which retain many of the high performance characteristics of the PVOH. Examples of the use of these PVOH materials and starch blends are reviewed for biomedical, industrial, and packaging applications which exploit advantageous properties including: high tensile and tear strength and puncture resistance; very low permeability towards oxygen, carbon dioxide and hydrocarbons; breathability towards water vapor; high chemical and oil resistance; good sealability and printability; and inherent static dissipation.

Biodegradable and compostable blends of polylactic acid with other biodegradable components have also recently been developed which are suitable for both flexible and rigid applications, including film, sheet, thermoformed shapes and injection- and blow-molding. These blends have significant property advantages over 100% polylactic acid for many applications, e.g. lack of low-temperature embrittlement and high barrier properties towards oxygen and carbon dioxide, and also process more easily without needing equipment modifications. They are particularly advantageous for food packaging applications to provide completely biodegradable packaging at lower cost than other biodegradable materials. Even less expensive high-clarity versions which are anticipated to have costs approaching polypropylene are also under development.

These water-soluble and biodegradable PVOH- and PLA-based products and blends represent viable environmentally advantageous alternatives to present non-degradable thermoplastics such as polyethylene, PET and PVC for many applications.

GPEC 2006 Paper Abstract #20B

Title: The Effect of Fiber Surface Treatment on Laminated Biocomposites from Poly(lactic acid) (PLA) and Natural Fibers

Authors: Manjusri Misra , Masud S. Huda, Lawrence T. Drzal**,** Composite Materials and Structures Center, 2100 Engineering Bldg. Michigan State University, East Lansing, Michigan 48824 and Amar K. Mohanty School of Packaging, 130 Packaging Bldg. Michigan State University, East Lansing, Michigan 48824

ABSTRACT

The kenaf and the pineapple leaf natural fiber reinforced poly(lactic acid)PLA laminated environmentally friendly biodegradable biocomposites were processed by thermal pressing using the film stacking method. Samples were made using kenaf or pineapple leaf fiber (PALF) or glass as the reinforcement and PLA or PP as the resins following identical procedure and parameters. Mechanical, thermomechanical and morphological properties of the composites and biocomposites were evaluated. The flexural modulus (> 8 GPa) and the flexural strength (> 40 MPa) of the PLA/ biocomposite (50 wt % fiber content) were comparable to those of glass fiber-polyolefin composites. This is considered to attribute to the strong interaction between the kenaf fibre/ pineapple leaf fiber and PLA. The composite with 50 wt % kenaf fiber contents exhibits the impact strength of 49 J/m, while neat PLA matrix exhibits the impact strength of 26 J/m. These natural fibers reinforced PLA composites also possess superior thermal properties. The heat defection temperature (HDT) of the natural fiber reinforced PLA laminated composites is significantly higher than the HDT of the neat PLA resin. Silane- and alkali- treated fiber-reinforced composites offered superior physical and mechanical properties over that of untreated fibers. The results show that these kenaf and the pineapple leaf natural fiber reinforced laminated PLA composites may be used in a large number of applications where higher cost and higher mechanical properties of glass composites are not justified.

GPEC 2006 Paper Abstract #1A

Title: Automotive Foams and Composites from Renewable Resources

Authors: Ellen C. Lee, Cynthia M. Flanigan, Kelly A. Williams, Debbie F. Mielewski, Christine Perry, Ford Motor Company, Dearborn, MI 48124

ABSTRACT

The use of renewable resources in automotive materials has been a focus of research at Ford Motor Company. These materials include polyurethane foams based on soybean oil, natural fiber reinforcement in composites, and compostable resins based on corn. In addition to an improved environmental footprint, these materials can also offer cost savings and, in some cases, weight savings over traditional petroleum-based materials. This presentation will address the key technical challenges and advances in the development of hemp fiber reinforced SMC (sheet molding compound) and soy-based flexible foams. For hemp SMC, several fiber treatments and sizings were investigated for improving flexural and tensile strengths, as well as to inhibit moisture uptake. The formulation for flexible soy-based foams was optimized for mechanical properties and odor. Both types of materials were evaluated against typical desired properties for automotive applications with promising initial results. Trials of demonstration parts have also shown feasibility for commercial application. Next steps for improved fiber dispersion for hemp SMC, optimized SMC formulation, and elimination of soy odor in foams will be discussed.

GPEC 2006 Paper Abstract #2A

Title: Creation of Vibrant and Long-Lasting Coatings for Light Trucks and Automobiles with Reduced Emissions to the Environment using Paint Film Technology

Author: Gordon C. Miller, MM&A LLC

ABSTRACT

Is there a better way to both create vibrant and long lasting coatings for light trucks and automobiles while reducing emissions to the environment of volatile organic compounds?

Based on USEPA evaluation of the coating of light trucks and automobiles, an estimated 132.40 lbs. of volatile organic compounds (VOC's) are discharged into the environment during several vehicle coating steps. (EPA, AP-42) For a typical 240 ft^2 automobile surface, the emissions are judged to be about 0.55 lbs VOC/ft^2 of surface area. With anticipated MACT reductions, this could drop to about 31.77 lbs of VOC and about 0.13 lbs VOC/ft^2.

The development of an alternative material that can be manufactured in a controlled process reducing the emissions to the environment of volatile organic compounds for coating light trucks and automobiles has been developed. Based on several white and black color options, the amount of emissions from coating an automobile using this new technology reduces emissions from 0.13 lbs VOC/ft^2 to actual emissions for the new product range from 0.0024 lbs VOC/ft^2 to 0.0034 lbs VOC/ft^2 for the new product. This involves a combination of both reduced emissions by product design and by additional abatement required under regulations, the amount of VOC emissions to the atmosphere per car drops from 31.77 lbs VOC to a range from 0.576 lbs VOC to 0.816 lbs VOC per average vehicle depending upon color.

Based on the production of 5,000,000 light trucks and vehicles per year, the difference between normal or expected production discharges of 79,425 tons of VOC emissions/year would be reduced to a range between 1440 tons of VOC and 2040 tons of VOC per year.

This dramatic reduction would likely very positively affect air quality in the various vehicle manufacturing areas of the United States and, where applicable, in other nations. Based on preliminary data, the cost to the customer would be roughly the same or slightly reduced when compared with traditional paint coatings. Other features of the product is that it is repairable by relatively standard methods for damaged vehicles and can be manufactured to meet most every current color currently being used in vehicle manufacture. The result is designed to both meet current customer requirements and reduce dramatically environmental emissions.

GPEC 2006 Paper Abstract #6A

Title: Effect of Regrind on Vibration Welding Strength of Polyolefins

Authors: Ewa Lebert, Chung-Yuan Wu and Susan DeGrood Kozora
Visteon Corporation

ABSTRACT

Polyolefins are used in the automotive industry in various components from fairly simple console bins to complex instrument panels. Since scrap is unavoidable in manufacturing process, the use of regrind is important to maximize resin usage and to avoid landfill. In addition to evaluating the physical property changes at different levels of regrind, the application specific requirements are important. The effect of different levels of regrind on weld strength is one of the important factors that need to be considered in some automotive applications. This study evaluated the weld strength of polyolefins using a two-factor (meltdown and pressure), two-level design of experiments. Unfilled polypropylene copolymer samples at 0%, 25%, 50%, 75% and 100% regrind levels were welded to a TPO in a T-Joint geometry to simulate production situations. The highest weld strength was seen in TPO welded to itself and was used as the baseline strength. With the TPO to polypropylene welds, there was a 13% decrease in weld strength with the 0% regrind whereas at the 100% regrind level, the decrease in weld strength was only 5.6%. It was determined that the weld strength of the polypropylene material to itself was 36-44% lower than that of the baseline strength. Aside from the 75% regrind samples, the highest joint strengths were derived from the 1 mm meltdown and 1 MPa pressure settings. Thermal analysis of the propylene samples indicates that the material at the weld is more amorphous than that of the bulk.

GPEC 2006 Paper Abstract #7A

Title: Advanced Methods for Paint & Coating Removal from Recyclable Substrates

Author: Gregory L. Gibson, Ph.D., Applied Chemical Technologies, Inc. & Affiliates

ABSTRACT

Recyclability or re-use of painted or paint contaminated fixtures or parts have been a long term goal of commercial high production paint operations for decades. Historically, many methodologies and processes have been utilized to varying degrees of success including but not limited to caustic immersion, organic solvent immersion, media-blasting, pyrolisis (burn-off), heated and fluidized media, molten salt baths, ultra-high pressure water blasting, cryogenic blasting and others.

Many of the commercially available processes for paint removal are very limited with respect to part turn-around time, substrate impact and/or compatibility, process cost, safety or recycle options for waste stream generation.

Therefore, the scope of technology development and commercialization to be discussed evolved from the research initiatives of Applied Chemical Technologies, Inc., which sought to provide commercial alternatives to current industrial practices of high volume paint operations without changes to current process design; while at the same time reducing process cost, improving worker safety and greatly decreasing environmental impact. Furthermore, it was the intent of basic research initiatives to provide recycle options for rejected painted parts and components that were unrecoverable to the source generator based on current technology and manufacturing processes.

Therefore, new and alternative proprietary technology was developed to be utilized in existing paint operations and in off-line support systems for commercial applications such as paint "jig" cleaning, paint booth floor grate cleaning, recycling of painted parts with un-repairable paint defects such as mirror housings & bumper fascias as well as other fixtures and components; for the removal of paints and coatings from substrates desired for re-use or recycle.

The discussion will focus on immersion based paint removal technologies via surface selective depolymerization and adhesion defeating technologies that here to date have not been commercially employed. Commercial applications of the technologies will be demonstrated with respect to paint jig cleaning and the recovery of TPO bumper fascia's as either whole parts or in granulated form within original specification and suitable for re-molding. Further discussion will outline process advantages, reduced cost models, comparisons to competing technologies, options for recyclability and alternative materials and finally overall improvements and gains with respect to the environmental fate of the associated waste streams.

GPEC 2006 Paper Abstract #8A

Title: Automotive Comfort Technologies Supporting Sustainable Development

Authors: Hameed Khan, Francesco Schiavone and Jim Fisher

ABSTRACT

Like most industries, the automotive industry is confronted with environmental challenges related to vehicles emissions, consumption of non-renewable material, generation of waste during production and at end of life to name a few.

There is an increasing global stakeholder awareness, which finds its expression in new legislation and customer requirements. At the same time environmental friendly innovations are offering solutions in recycling or end-of-life alternatives, which represents great business opportunities and a huge potential.

Worldwide progress in sustainable mobility and in environmental performance of automobiles is counting on many success stories: in this paper some environmental-friendly products and technologies for automotive applications in Acoustics and Interior Trim composites are presented. Environmental management systems in manufacturing operations have become the “state of the art” as well, but upstream implications in product design and development still demand further development for adequate methods and applicable tools. Innovative visions on environmental market trend and design approaches are also presented; these are showing promising results for an environmental-conscious design of vehicles during the product development processes.

GPEC 2006 Paper Abstract #9A

Title: Recycling Exterior Grade Painted TPO’s

Author: Robert Egbers, American Commodities, Incorporated, Flint MI

ABSTRACT

Reconstituting exterior grade painted TPO's has been done for over 10 years. From the beginning, the goal has been to yield a reprocessed material that met virgin property specifications, which would allow re-use in painted exterior applications.

Over the ten-year evolution of this process, many challenges have been overcome. This paper discusses these challenges and demonstrates with data, recent production process performance.

GPEC 2006 Paper Abstract #10A

Title: Automotive Plastics Opportunities

Author: Steve Schellenberg, WorldPort Logistics Center/CMC Rail Yard, Dayton, TX

ABSTRACT

There is an established trend by import automotive producers to locate production centers in new locations in the United States and Canada. These centers of production are not located in the traditional automotive industrial centers in the northeast; rather, there is a specific trend toward locating production where access to markets, competitor's volume sales and export markets is available. As these green field locations come to maturity, there is an increasing amount of pressure to locate a campus of Tier I suppliers in the same location, and even the same Industrial Park.

GPEC 2006 Paper Abstract #E1

Title: Recycled Electronic Housings Mixed ABS Material and Flame Retardant Identification Using Near-IR and Mechanical Testing

Author: Mike W. Dattner, University of Wisconsin Polymer Engineering Center

ABSTRACT

Electronics reclaimers are generating rising volumes of mixed ABS plastics from the processing of computer equipment and televisions, which represents a large market opportunity. Within our research we are investigating the processability of this scrap and the properties of the resulting material. Our prior research has shown repeatable mechanical properties. One issue that we have not addressed in the past is the presence of flame-retardants, some of which may be hazardous. To fully classify the material we have identified the individual housings materials and flame-retardants by several methods. By conducting a survey where we cataloged the weight, description, and any markings on the housings over a several week time span we have a better understanding of the percentage of ABS in the stream. Since over half of the materials by weight are not identified, we used a Near-IR spectroscope on 20 randomly selected housings to identify and catalog the materials, as well as the existence, type, and content of flame-retardants. The next step was to run mechanical tests on the 20 materials, individually and mixed, to determine if sorting of parts would provide better materials. We also addressed the impact resistance problems of recovered mixed ABS materials by adding a rubber modifier to the mixture.

GPEC 2006 Paper Abstract #E2

Title: R**ecycling Mixed Plastics from End-of-Life Electronics**

Authors: Adam Al-Mulla* and Rakesh K. Gupta, Department of Chemical Engineering, West Virginia University, Morgantown, WV 26506

ABSTRACT

The main barrier to the recycling of post-consumer plastics into high value applications is the commingled nature of these materials with consequent poor and variable mechanical and flow properties. In our prior work, we have shown that more than 99% purity is needed to prevent a very significant loss of impact strength and ductility in polycarbonate [1]. Separating the polymers by chemical type, however, is prohibitively expensive, and it may still not completely solve the problem of batch-to-batch variability in properties that results from variations in polymer molecular weight and molecular weight distribution. In the present work, we have examined strategies for recycling mixed polymers, especially polycarbonate, from end-of-life electronics. In this effort, we have used a twin-screw extruder to add up to 20 wt% short glass fibers to virgin as well as recovered polycarbonate and their mixtures. This action results in a loss of transparency and toughness but an increase in dimensional stability and creep resistance. We have also measured the resulting impact strength, stiffness, ductility and viscosity and have found that these properties depend more on the amount of glass reinforcement than on the chemical make up of the polymer matrix; the truth of this statement is demonstrated by intentionally blending polymers such as ABS, HIPS and polyethylene into the polycarbonate. In particular, if 15 wt% glass fibers are employed, the polymer matrix can contain up to 25 wt% impurities, and the mechanical and flow properties are virtually indistinguishable from the corresponding properties of the glass-reinforced polymer formulated with 100% virgin polycarbonate. This says that, for purposes of recycling post-consumer polycarbonate, separation of commingled plastics is not necessary, and one can compound a "green" product having 25% recycled content (based on the resin) by the addition of an appropriate amount of short glass fibers.

1. R. Liang and R.K. Gupta, "The effect of residual impurities on the rheological and mechanical properties of engineering polymers separated from mixed plastics," Proc. Soc. Plast. Eng. 59th Ann. Tech. Conf., May 6-10, 2001, Dallas, TX, pp. 2753-2757.

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GPEC 2006 Paper Abstract #E3

Title: Using Portable XRF tools to meet EU's Restriction of Hazard Substances/Waste Electrical and Electronic Equipment (RoHS/WEEE) Requirements

Author: Jim Martin, Innov-x Systems, Woburn, MA

ABSTRACT

The Impact of ROHS / WEEE directives by the European Union will have a wide-ranging impact on materials used by manufacturers of electrical and electronic equipment ranging from computers and calculators to home electronics such as VCR's and TV's, appliances, toys and walkmans, and most other electronic or electrical devices. There is clearly a need for a systems approach to mitigating the impact of the RoHS / WEEE Directives.

You can get a certification of compliance, but what if someone else makes a mistake? What happens then? That's where this presentation may help. Innov-X is part of a complete systems approach. We play an important role in helping the manufacturer, the component supplier, contract manufacturer or service provider insure that beyond all reasonable doubt that their product is free of restricted elements.

With a point and shoot test capability you can be assured that your products and parts are free of restricted elements. We will discuss applications of handheld XRF analyzers to perform fast, precise and non-destructive RoHS/WEEE screening of plastic parts, circuit boards and electronic components for toxic metals. They can monitor toxic metals in ppm for RoHS/WEEE compliance verification and documented traceability. They can quantify Pb, Hg, Cd, Cr and other heavy metals, and identify PVC, Br- or Sb- or P-based flame retardants in seconds. They can also evaluate lead in solder for Pb-free requirements, and can quickly sort chlorinated and/or brominated plastics."

GPEC 2006 Paper Abstract #E4

Title: Large Scale Co-combustion of Plastics from the End-of-Life Electrical and Electronic Equipment at the Wuerzburg Municipal Solid Waste Energy) Recovery Plant (MHKW

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ABSTRACT

In a controlled test campaign, a broad consortium of international stakeholders has demonstrated the effects of end-of-life electrical and electronic equipment shredder residue (ESR) on the performance of a large scale municipal solid waste energy recovery combustor MHKW in Wuerzburg, Germany. The ESR was highly concentrated with electrical and electronic plastics. Three test conditions were investigated: 1) base case without additional electrical and electronic shredder residue, 2) addition of 11 weight percent ESR containing E&E plastics, 3) addition of 26 weight percent ESR with E&E plastics. The fact that some waste electrical and electronic equipment is already in the mixed MSW feed to many waste-to-energy plants made the testing important for the MHKW operator as well as for the local regulatory authorities (EPA). The tests investigated the effect of ESR on plant operations, air emissions (acids, organics, and metals), ash characteristics, and significantly, on the destruction efficiencies for several chlorinated and brominated substances present in the ESR.

The large scale test used 103 tons of ESR derived from 650 tons of a typical mix of information technology equipment, consumer electronics, small household appliances, and other products. The ESR was supplied by Electrocycling in Germany. The tests were successfully completed from an operational standpoint without long time delays and did not show any mechanical blockage during the test in spite of the high heating value, 23 GJ/t, of the ESR. The grate was operated at close to 90 percent throughput.

Clean gas concentrations of chlorinated dioxins/furans were all well below the 0.1 ng ITE /m^3 regulatory limit. Raw gas HCl and HBr concentrations were in the expected range of 1000 - 2000 mg/m^3 and 50 - 200 mg/m^3, respectively. The conditioned dry lime addition system worked well for a feed concentration of 11 wt % ESR to 26 wt % ESR. The clean gas HCl concentrations could be kept below the limits of the plant's permit in accordance to the European Waste Incineration Directive. It has been shown that high levels of ESR can be handled with standard commercial equipment. The heavy metals raw gas concentration was in line with what can be expected from typical metal and heavy metal volatility behavior. Most heavy metal raw gas concentrations were lower than observed during a 1997 test using automotive and appliance shredder residue (ASR). Decomposition of trace organics such as PCBs and halogenated dioxins and furans as well as flame retardants of the PBDE type during co-combustion was demonstrated to be sufficiently high to ensure nearly complete destruction of these organic compounds. The heavy metal leaching of grate ash has been assessed with good results using the European, German, Dutch and USA procedures. The Wuerzburg test demonstrated the significant potential for modern municipal solid waste energy recovery plants, in conjunction with other recovery options, to play an important role in the sustainable recovery of plastics from end-of-life electrical and electronic equipment.

GPEC 2006 Paper Abstract #E5

Title: RoHS Challenges and Restricted Substances Compliance Solutions

Author: George J. Fechtmann, PE, Underwriters Laboratories (UL), New York

ABSTRACT

OEMs and suppliers are faced with business continuity and risk management issues due to environmental regulations. This supply chain challenge is being faced worldwide and is part of a growing trend. As OEMs and suppliers plan and execute their compliance strategies, the use of alternative approaches must be carefully considered as a means to complete this daunting task. The role of XRF screening tests, conventional digestion/extraction analysis, on-site inspections, databases, spreadsheets, self-declarations and other relative tools will be discussed as potential resources that may be part of an overall compliance program.

GPEC 2006 Paper Abstract #R&S1

Title: Technological Advancements in Separation and Sorting Technology for Recycled Plastics

Author: Peter Mayer, Sales Manager, Recycling Technology, S+S Separation and Sorting Technology GmbH, Schoenberg, Germany

ABSTRACT

In the recovery of useful polymeric materials from recycled scrap streams, the recycler is confronted with the need to separate the metallic contaminates present in the stream as well as sorting color and polymer type of the “accept polymer” from the “reject polymer”. This paper will present a summary of the most significant advancements in separation and sorting technology to achieve maximum product yield.

As reported by PET recyclers, the whole bottle recycle stream can contain up to 2% of metallic contaminate. This needs to be sorted and separated to protect the downstream size reduction machine from damage. Conventional metal detector/separators can produce over 25% lost product, while the product yield using an advanced technology detector/separator is around + 99% The bottle stream may also contain up to 10% of “reject color” which also need to be separated. Product yields of + 99.5 % can be realized when using a Color-Separator-Spectrum. There is also the distinct possibility of renegade bottles in the stream; i.e. HDPE, PVC, etc. these also need to be sorted and separated from the PET “ accept “ stream. Several advances in sorting and separation technologies shall be reviewed.

Certain facilities reprocess PET from flake which may contain up to 500 ppm of small metallic contaminates; i.e. aluminum from caps which were ground in the size reduction machine. Obviously, if these flakes are to be reused in food applications, the metallic contaminates require removal. Using a advanced separation technologies,, product yields of 99.9% are readily achieved. The flake stream can also contain renegade polymers; i.e. PVC. PVA, HDPE or pigmented flakes. The optimum separation of “ accept” from “ reject” is economically mandatory.

For a recycler to economically reprocess scrap polymeric materials from recycle streams it is mandatory the facility removes machine damaging metallic contaminates, sorts and separates renegade polymers and colors from the stream and produce the highest value end product by achieving product recoveries of + 99%.

GPEC 2006 Paper Abstract #R&S2

Title: Carpet Reclamation

Author: Bob Peoples, PhD, Director of sustainability for the Carpet and Rug Institute and Executive Director of the Carpet America Recovery Effort (CARE).

ABSTRACT

This presentation will focus on 3 elements: progress to date by the CARE organization members, the growing range of option for recycle of post consumer carpet and product made with this increasingly valuable resource and growth projections over the next 3 years. Sample and photos of products and their application will be abundant to stimulate and spark interest. The talk will highlight this budding industry along with opportunities.

GPEC 2006 Paper Abstract #R&S3

Title: Quality Assurance Testing Protocol for Postconsumer Resins (PCR) in California

Author: Joseph P. Greene, Ph.D., Professor Department of Mechanical Engineering Mechatronic Engineering and Manufacturing Technology California State University Chico Chico, CA 95929-0789 530-898-4977

ABSTRACT

Quality assurance is needed in California for postconsumer resins (PCR). The quality assurance programs at several Californian postconsumer plastic processors were developed with a new model quality assurance programs for post-consumer resins. The quality control system is applicable to the major recycled plastics, for example, LLDPE, LDPE, MDPE, HDPE, PP, PS, and PET. The PCR quality guidelines are useful for a range of products, including, trash bags, rigid packaging, and plastic lumber. The PCR guidelines are used during PCR manufacturing operation when the incoming plastic material is received, processed, and packaged in a Gaylord. The study suggests different quality levels of PCR with different levels of documentations, specifications, and testing requirements. The guidelines describe five quality levels of postconsumer resin (PCR), ranging from quality level 1 for near virgin plastic quality to quality level 5 for near recycled plastic lumber quality. The PCR quality guidelines encompass all five grades of PCR materials, though different grades will have different testing standards, material specifications, and process control. The quality assurance program can help PCR manufacturers improve the quality of PCR and provide them with a more consistent product that will ultimately lead to higher profitability and increased PCR usage in California.

GPEC 2006 Paper Abstract #R&S4

Title: IRD INFRARED ROTARY DRUM DRYING

Author: John W. Doub, Jr., Novatech

ABSTRACT

Reclaimers and suppliers of Bio-Based, and Biodegradable polymers, and processors of PET – particularly Post-consumer regrind -- are currently using drying and/or crystallizing procedures to prevent splay and imperfections in product, as well as maintain intrinsic viscosity. This "conventional" drying process, which has been used for many years, may take as long as six hours. New technology has recently become available which allows moisture removal for processing PET in as little as 8 minutes. This results in substantial energy savings, coupled with allowing the flexibility associated with reduced inventory. The process of Infrared Drying is covered worldwide through several patents resulting from the original filing in Germany. This new drying technology has been improved through years of continuing testing and research to the point that it is now proven to be extremely successful in commercial applications.

In conventional thermal drying of hygroscopic resins, the material must be heated externally, then internally, to drive the moisture to a dehumidified air stream where it is removed. Infrared Rotary Drum (IRD) drying causes molecular heat oscillation directly to the core of the material so it vaporizes internal moisture which is then removed by cool air.

Because of the substantial energy savings and flexibility in drying virgin and post consumer regrind materials with the IRD drying process, recyclers and processors of PET and other resins have now the tools available to reduce inventories and lower costs associated with production operations. Recyclers and processors in Europe, Australia and Japan are enjoying these benefits, and predictions for the future indicate this process will become prevalent throughout North America.

GPEC 2006 Paper Abstract #R&S5

Title: Recycling of Fibers and Non-wovens

Author: Barry Hunter, Starlinger-Sahm, Inc.

ABSTRACT

Why and how to recycle in-house or post-industrial waste?
A variety of economic factors (e.g. rising resin prices, cost reduction pressure, fierce competition) led to higher awareness concerning production costs. Waste management is only one aspect when managing costs but can play a major role. Although companies emphasize the concept of zero-waste, production waste cannot be avoided 100 %.

Starlinger emphasizes the idea that production waste is a valuable secondary resource. Recycling is the first step in a second life-cycle. High-quality re-granulate becomes a cost-saving alternative to virgin material. If the production waste is processed in-house, a company does control the quality of the re-granulate with its materials management. In some cases costs for waste disposal are avoided. Additionally it is increasingly important to reduce personnel costs thus a fully automatic recycling line operated by the production people has its merits.

GPEC 2006 Paper Abstract #R&S6

Title: It's not easy Being Green, Especially when it's Brown!
Diapers: The Ongoing Recycling Opportunity

Author: Keith Bell, Recycling Programs, Inc

The Canadian company, Knowaste, a leader in disposable diaper recycling, is fighting an uphill battle having had programs FAIL in California and Canada. Efforts in the Netherlands are to be determined. Challenges are many, including a very water-intensive process. It takes a lot of water to clean dirty diapers and a lot of places just don't have enough water to waste!! Water is a precious resource. Also, there are issues of sanitation; people are afraid dirty diaper recycling poses a real health threat.

Of course, there are many opportunities to recycle disposable diapers. They add up to mountains in our landfills, even though they don't account for a very large percentage of our total waste stream. Actual figures in terms of diaper sales in FL to be determined.

On the other hand (or tush, whatever the case may be), many cloth diaper cleaning services have also failed. Most people just don't find them appealing in this age of disposables. Try to find a cloth diaper cleaning service in FL; you may be hard-pressed to locate one! Basically, these services will pickup dirty diapers at your home and deliver clean ones. But would you trust them to deliver clean diapers another baby has already used? Perhaps the best way to use cloth diapers is to clean them yourself by scraping waste into the toilet and washing them in your own washer.

Recycling Programs, Inc. (RPI) has been involved in diaper scrap recycling from manufacturers where there are truckloads of clean material available. When diapers are manufactured, there are a couple different types of trim. Some of it is pure plastic (polypropylene) and much of it is a mix of polypropylene, polyethylene and super-absorbant fluff. The fluff is very difficult to recycle. It's also very difficult to recycle mixed plastics (most need to be sorted by type). About the only application for all this diaper scrap is recycled plastic lumber. Plastic lumber is an excellent, long lasting material and perhaps healthier, though more expensive, than traditional pressure-treated wooden decks which contain chemicals such as arsenic leaching for decades into our environment. At this time, most plastic lumber manufacturers do not utilize diaper scrap.

RPI has densified (a term used in the plastic recycling industry) diaper scrap. We have transported truckloads of diaper scrap from a manufacturer and shipped it to a toll grinder for densification. We've had a difficult time finding anyone who wants to use this material make a new product. Still, we believe there are markets for diaper scrap, most of which is currently landfilled.

We've heard about sorting lines in China where material is actually hand-sorted in order to remove super-absorbant fluff.

Because Florida's population is bursting and the fact that we depend on our aquifer system for clean drinking water, we should be especially motivated toward pioneering an effective system to recycle used, disposable diapers. There is much education to be done and technological breakthroughs are necessary for the success of disposable diaper recycling.

GPEC 2006 Paper Abstract #R&S9

Title: Success of Closed-Looped Plastic Recycling Systems: A Case Study focusing on recycling PVC materials and how this business strategy can decrease your material costs and increase your profits

Author: Anthony Georges, Vice President, AMUT & ARIOSTEA North America,
55 Regal Crest Court, Woodbridge, Ontario, Canada, L4L 8P3

ABSTRACT

The presentation will examine the complete operations of an existing recycling plant for PVC waste materials from post-industrial, post-construction & post-consumer, coming from many regions of North America and operates at almost 20,000 pounds per hour. We will also learn how the plant compounds, palletizes, handles and stores 400,000 pounds of material per day, seven days per week, 365 days a year!

We will then examine some of the final products that are made from these recycled materials, such as factories, car wash centers, seawalls, and a wide variety of other buildings & structures.

GPEC 2006 Paper Abstract #R&S10

Title: A Case Study of a PVC Pipe Recycling Program

Author: Preston Creelman, P.Eng., Specification Engineer, Royal Pipe Systems

For the past three years, our company has had a program with the City of Abbotsford to accept its surplus PVC sewer and water pipe for recycling back into sewer pipe production. PVC end-cuts are generated when full lengths are cut off to allow various fittings to be placed at their designated locations in the water and sewer systems throughout the City of Abbotsford. "We are committed to the sustainability of the environment," said Jim Gordon, P. Eng., Director of Engineering, City of Abbotsford, "and this program has added another dimension to our already extensive recycling initiatives. The fact that we can partner with a local producer/employer to accomplish this end is an added bonus."

GPEC 2006 Paper Abstract #R&11

Title: Who Says PVC Can't Be Recycled? An interview with Tom Franzen, Plant Manager Specified Fittings, Inc.

Author: Craig Fisher, P.E., Technical Director, Uni-Bell PVC Pipe Association

Author's Preface: The content of this paper comes directly from an interview I had with Tom Franzen. The question-and-answer format of the interview lent itself to writing the article in first person, from Mr. Franzen's point-of-view. That literary license was taken to make the article more readable.

ABSTRACT

Scrap is a fact of life when one is a manufacturer of fabricated plastic fittings. When Specified first began, its available financial resources were focused on the purchase of fitting manufacturing equipment, modifying the facilities to better suit our needs, and all the other countless items that go into getting an operation like ours off the ground. At the time, the funds just were not available to purchase the additional equipment we needed to pursue the recycling of our scrap.

That is no longer the case. Specified Fittings has a very healthy and economically viable recycling program in place. Since the program began, we have processed between 3.5 and 4.0 million pounds of scrap, which we shipped to our recycling broker, Plastic Industries, of Preston, Idaho. The investment in the recycling equipment was paid back within months. Having paid off the equipment, the program's profits now go straight to the bottom line.

GPEC 2006 Paper Abstract #R&12

Title: **Closing the Loop in the Plastic Film Industry**

Author: Daniel Schrager, President, NextLife Recycling

ABSTRACT

Over the past 15 years, the plastic film and bag industry has grown at a significant rate producing billions of pounds of grocery and retail bags, stretch wrap and other film scrap each year. And although recycling is not a new concept for many markets including paper, cardboard and plastic bottles, it has yet to be embraced for the plastic film industry. In fact, recycling recovery rates for paper, cardboard, plastic bottles and certain metals have continued to rise over the past few decades. This is in part due to environmental concerns, municipal curbside collection programs and consumer education. However, the recovery rate for plastic film has achieved at best estimate of only 5%. This presentation will look at the plastic film recycling industry and discuss the economic and environmental factors that contribute to—and detract from—the successful recycling of this material.

Plastic film recycling will be the next recycling success story. Packaging manufacturers, durable goods manufacturers, municipalities and other waste generators are realizing the economic and strategic benefits of recycling plastic films and reusing the material to produce new products—resulting in significant cost savings for both manufacturers and consumers. And while legislators propose taxes and bans on plastic bags in an effort to discourage and reduce bag use, the industry has developed market-driven solutions that focus on closed-loop recycling. Grocery and retail bags, stretch wrap and other film scrap can--and are--being recycled into different products for industries such as automotive, agriculture and consumer products.

This presentation will focus on the plastic film recycling industry and closed-loop recycling solutions. Some of the questions that will be addressed include:

- How are plastic films used in packaging today?
- What threat does plastic film pose to the environment?
- What are the barriers that companies and municipalities face when recycling plastic film?
- What limited markets have existing in the past?
- How have markets expanded for recycled plastic film?
- What new technologies are available for plastic film recycling?
- What is the outlook for plastic film recycling?

Who should attend this presentation?

This presentation will be of interest to municipal, commercial and academic professionals who have an interest in researching, developing, implementing, promoting or lobbying for plastic film recycling programs.

About NextLife Recycling

NextLife Recycling is a plastic and film recycling company focused on developing post-consumer programs for municipal and commercial markets. NextLife collects and recycles millions of pounds of plastic each year, with material recovered from nearly every state and province throughout North America. NextLife converts recovered plastic films into 100% recycle-grade resins, which are used to make new products such as trash pails, recycling bins, pallets, park benches and more. www.nextlife-recycle.com.

GPEC 2006 Paper Abstract R&S13

Title: The Dilemmas of Plastic Wastes in a Developing Economy: Proposals for a Sustainable Management Approach for Ghana

Authors: Julius N. Fobil, Research Fellow, School of Public Health, College of Health Sciences, P. O. Box LG13, University of Ghana, Legon, Accra., Jonathan N. Hogarh, Lecturer, Environmental Science, Department of Theoretical and Applied Biology, Faculty of Biosciences, Kwame Nkrumah University of Science & Technology, Private Mail Bag, University Post Office, Kumasi, Ghana

ABSTRACT

It is a common phenomenon in many West African countries to have places where food and drinking water are sold to the general public cited in the open space. This is usually anywhere near offices, market places, public schools, churches and in any available open space in the Central Business Districts (CBDs) within the cities. The most common of this kind of trade is that practiced by vendors of drinking water and food who use walkways and pavements as the premises of their businesses to market their merchandise to people in moving vehicles. In the late 1970s, it became apparent that easy spread of such food and water borne diseases as typhoid, cholera and dysentery in events of epidemics were intricately associated with these cultural practices in food and water industry. This discovery imposed a safety requirement on street vendors to institute new ways of food and water handling that would be safe and healthy so as to minimize the risk of disease episodes associated with the marketing of cooked-food and drinking water. The growing awareness in safe and proper modes of food packaging as well as increased need for more hygienic methods of handling drinking water to safeguard public health triggered off a decade of tremendous increase in the use of plastic products in West Africa. Plastics became the obvious choice for food and water packaging because of their inherent properties such as low bulk densities and inertness that make them convenient carrier materials and low-risk contaminants. Plastic bottles and sachets used to package iced-water that is sold to people in transit points and in moving vehicles became widespread in the sub-region. However, the packaging revolution was not backed by appropriate plastic waste management policy, which left the cities littered with plastic wastes, thus creating disgusting visual nuisances and other public health problems. . This paper discusses the experiences, challenges and prospects of plastic waste management schemes in Ghana and proposes a new model of fractional levy and polluter tax system to address this environmental eye-sore.

GPEC 2006 Paper Abstract #R&S14

Title: New Technological Solutions for Reducing Landfill Waste

Authors: M. A. McMillan, T. Black, M.B. Johnston and T.A. Cooper (Environmental Technology Associates, Inc.)

Two innovative waste-to-product technologies that convert municipal solid waste (MSW) and discarded tires into profitable end products have recently been developed. (i) The "Dura-Build" technology first removes glass and metals from MSW and then converts the entire resultant waste, with no separation or sorting of plastics or other components, using heat, steam and other sterilization treatments and comminution processes, into a fine filler material with controlled moisture content. This filler is then impregnated and encapsulated with reactive polymer-forming binders such as urethane or phenolic systems to convert it into rigid thermoset composites and foamed structures for wood replacement applications, e.g. particle board, construction materials and other products by compression molding, extrusion, foam molding or other processing methods. The final products contain high levels of the processed waste fillers to provide combinations of favorable economics with advantageous properties. (ii) The "Tycon" technology first shreds and then thermally devulcanizes discarded tires, at extremely high efficiency levels, using controlled infra-red heating, into carbon black, fuel oil and fuel gas (directly convertible to energy) as well as recovering stainless steel from the tire carcass. These two technologies have also been combined with established processes for converting green waste, food waste and sewage into high-grade compost, liquid or solid fertilizers, and fuel products. Waste conversion plants using combinations of these processes, collectively known as "Convertec", can be customized, based on the composition and size of each specific waste stream, to divert waste materials from landfills and convert them into the desired range of highly marketable, competitively priced products. These systems offer distinct financial advantages in that the plant owners are paid to take the raw materials comprising high proportions of the end products, thereby reducing direct costs and increasing profit margins, and no separation or sorting of waste plastics is required. Such combination systems also offer distinct environmental advantages: waste now considered "non-recyclable" is diverted from landfills and made useful; waste in existing landfills can be reclaimed and recycled without sorting; and debris left in the aftermath of natural disasters such as hurricanes, floods and earthquakes can be reclaimed and turned back into products used for rebuilding. These recycling systems not only have the potential to greatly reduce or eliminate world-wide environmental waste disposal problems, but also provide usable products that reduce demands on non-renewable resources.

GPEC 2006 Paper Abstract R&S15

Title: Recycling Processes which Enable Economical Conversion, Including that of Difficult to Handle Materials

Author: Michael Horrocks, Erema North American, Inc.

ABSTRACT

Production waste can often represent up to 5-7% of the manufacturing output . One of the targets of the recycling equipment manufacturer is to make this achievable in an efficient way which blends in without compromising production processes or compromising the company's core business.

EREMA continue to look at customers requirements and at EREMA we have developed a number of systems which lend themselves to this target.

The **EREMA KAG** system for the handling of trim and rolls stock from PE production waste, it will automatically follow line output / speed changes, start and stop itself so as to minimize operator involvement but at the same time produce a pellet which when introduced back into the production process is often not recognized as recycled material.
It can also often handle many multi layer structures such as PE/PA and PE/PET mainly being re-introduced as a recycled layer in the final product. The cost is low because of the automatic nature of its operation

GPEC 2006 Paper Abstract #R&S16

Title: Study on the Construction of Flexible Road Using Plastic Coated Aggregate

Authors: Dr. R. Vasudevan, Professor & Head, Department of Chemistry, Thiagarajar College of Engineering, Madurai – 15 Tamil Nadu – India, S. Rajasekaran, Project Associate, Dept. of Chemistry, Thiagarajar College of Engineering, Madurai – 15 Tamil Nadu – India

ABSTRACT

The studies on the use of polymer-modified bitumen (PMB) for flexible pavement are being carried out by different schools. Virgin & recycled polymers are being used for these studies. Use of disposed plastics waste is the need of the hour. The studies on the thermal behavior and binding property of the molten plastics promoted a study on the preparation of plastics waste – bitumen blend and its properties to find the suitability of the blend for road construction. The blend is almost similar to PMB. But, when higher percentage of plastics waste was used, the polymer got separated from the blend. A modified technique was developed and the stone aggregate was coated with molten plastics and the plastics waste coated aggregate (PCA) was used as the raw material for flexible construction. PCA showed better binding property. It had less wetting property. Its voids were much less. The sample showed higher Marshall Stability value. The roads laid using PCA are performing well. A detailed studied is presented.

GPEC 2006 Paper Abstract #REG1

Title: Current Issues & Regulatory Status Concerning Flame Retardants

Authors: Raymond B. Dawson and Susan D. Landry, Albemarle Corporation, 451 Florida Street, Baton Rouge, LA 70801-1785

ABSTRACT

Plastics are used in countless products that improve our quality of life. Many of these products that we use on a daily basis incorporate flame retardants as a passive means of fire protection to help safeguard society. In the end-use application, flame retardants delay the spread of fires or delay the time of flashover in order to enable people more time to escape the effects of the fires. The ultimate purpose of their use is to save lives, reduce injury, reduce destruction of property, and reduce local pollutants that result from fires. Research has shown that since the use of flame retardants in applications such as furniture and TV housings began, a substantial reduction in fire deaths has been achieved.

Flame retardants are coming under considerable scrutiny due to perceived environmental and toxicological issues. Many of the conclusions that have been drawn are broad generalizations based on limited data that is applicable to only a few specific flame retardants. A great deal of information is publicly available on the potential health and environmental effects of commonly used flame retardants. Several of these flame retardants, both brominated and phosphorus, are currently undergoing EU Risk Assessments. This paper will address the current regulatory status of flame retardants, with specific emphasis on the commonly used flame retardants. Updates on the status of the EU Risk Assessments, US activity, and worldwide regulations involving flame retardants will be presented.

GPEC 2006 Paper Abstract #REG2

Title: Challenges Faced By Thermoplastic Suppliers Due to WEEE and RoHS Directives

Author: Nancy Concepcion, Spartech Plastics

ABSTRACT

With more and more electrical and electronic items becoming affordable, coupled with the shorter life cycle of these products, millions of tons of EEE are sent to landfills every year. The WEEE Directive encourages product design to take into account repair, reuse and recycling at end-of-life. In support of the WEEE Directive, the RoHS Directive aims to reduce the amount of certain hazardous chemicals used in production. Eliminating hazardous chemicals increases the viability of recycling materials because there is a reduced risk to human health from exposure particularly for recycling staff as well as reducing potentially negative environmental impact.

This presentation will describe some of the unique challenges faced by thermoplastics suppliers as a result of these directives. Solutions for overcoming these challenges will also be discussed.

GPEC 2006 Paper Abstract #REG3

Title: Emission Modeling of Styrene from Vinyl Ester Resin: Effect of Styrene Percentage, Temperature, and Resin Depth

Authors: Rahul Jain, Uday K. Vaidya, University of Alabama at Birmingham, Department of Materials Science and Engineering, Birmingham, AL 35294; Chad A. Ulven, North Dakota State University, Department of Mechanical Engineering and Applied Mechanics, Fargo, ND 58105; James M. Sands, John J. La Scala, Joshua A. Orlicki, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Aberdeen Proving Grounds, MD 21005; Giuseppe R. Palmese, Drexel University, Department of Chemical and Biological Engineering, Philadelphia, PA 19104

ABSTRACT

The use of vinyl ester (VE) resins in structural composite applications within the commercial and defense sectors has increased dramatically in the last decade. Styrene is a reactive monomer in VE resins, providing diluency to the resin system required in many liquid molding methods. Styrene is considered a volatile organic component (VOC), hazardous organic pollutant (HAP) and is currently under investigation for carcinogenic effects. The National Emission Standards for Hazardous Air Pollutants (NESHAP) program has enacted stringent Maximum Achievable Control Technology (MACT) standards which regulate the use and/or emission of styrene. A model to describe mechanisms of evaporation and diffusion from a styrene containing VE system was implemented based on an evaporation based diffusion model. In this study, the emission of styrene for various parameters including resin depth, test temperature, and styrene concentration have been investigated. It was observed that the emission rate and amount of styrene decreases with increasing resin depth, or decreasing exposed surface area for a particular period and resin system. It is also shown that diffusion coefficient and evaporation coefficient of styrene have an exponential relationship with temperature and styrene concentration. These efforts will lead to the development of a modeling tool capable of predicting the life-long emissions of VE based composite structures.

GPEC 2006 Paper Abstract #REG4

Title: The Health and Environmental Effects of the Production, Use, and Disposal of Polyvinylchloride

Author: Ryan Hertel and Nick Newman, Mechanical Engineering Department, University of Wisconsin-Madison

ABSTRACT

In spite of all of its advantages, the use of polyvinylchloride (PVC) poses serious health and environmental risks. From the serious problems associated with the manufacture of the polymer itself, to the damaging effects of its disposal, PVC poses a danger throughout its life cycle.

The manufacturing of PVC exposes plant workers and residents of nearby communities to significant health risks. While PVC is relatively safe to handle, the vinyl chloride monomer is not. In the United States alone, 126,000 employees work in PVC plants, and 9,000 employees are directly involved with the production of vinyl chloride. These employees have a history of contracting angiosarcoma, a rare form of liver cancer. The US Department of Health and Human Services has declared vinyl chloride a human carcinogen. Emissions from these production facilities subject surrounding communities to increased health risks from air and water pollution.

Potential health risks with PVC continue long beyond the production process. PVC has been linked to the release of dioxins, highly toxic substances that can be carcinogenic. These dioxins have the potential to be released during the products life. American and European companies such as General Motors, Volvo, Nike, and Mattel have begun eliminating PVC from consumer products due to its possible dangers. PVC also poses problems in homes due to the danger of a house fire. When burned it can release toxic additives and harmful gasses into the air. As more than half of all PVC is used in construction, this is a serious issue.

Even when disposed of by proper waste management facilities, PVC cannot be effectively recycled. Therefore, vinyl waste is often incinerated, releasing dioxins and other toxic agents into the atmosphere. It is estimated that municipal waste disposal of PVC exceeds five hundred million pounds annually. If PVC is not incinerated, it is instead sent to landfills, where toxic substances in the plastic can break down over time and leach into the surrounding water table.

Throughout its entire life cycle, PVC poses health and environmental risks that need to be considered when making engineering decisions. Worldwide, it is estimated that three hundred billion pounds of PVC have been put into use within the past forty years. Production and use of PVC continues to grow and PVC consumption in US and Canada is expected to reach 14.7 billion pounds by 2007. All of this PVC will require disposal in the upcoming years. With no safe method for disposal of PVC, it is even more critical for consumers and engineers to be conscious of the long range effects of utilizing PVC.

Many other countries have taken the first steps towards reducing or eliminating PVC, replacing it with other plastics. However, PVC continues to be the second-most produced plastic in the world. This paper seeks to generate awareness of PVC and its detrimental properties in the hope that engineers and consumers can make informed decisions regarding the use of PVC.

GPEC 2006 Paper Abstract #REG5

Title: Use of Plastics with Care: Code for India

Author: Dr. Mrs. N. Rajalakshmi, Director Agro Economic Research Centre, Professor, Environmental Economics, University of Madras, Chepauk, Chennai- 600 005., India

ABSTRACT

Plastic is one the best inventions of the century. It is used in so many industries that it's almost as if we cannot do anything without it. Plastics are non-biodegradable polymers of mostly containing carbon, hydrogen, and few other elements such as chlorine, nitrogen etc. Due to its non-biodegradable nature, whether the plastic waste contributes any problem? The problems have been sorted out in other countries by improving civic consciousness, creation of adequate infrastructure for dealing with solid waste and involvement of the industry in recycling efforts. The items in demand for plastics will be of high quality packaging, white goods, plastic furniture both indoors and outdoors, crates, bottles, door and window frames for the construction industry. The fastest growing segments will include tele-communications and power, automobiles, packaging, appliances, electronics and agriculture.

GPEC 2006 Paper Abstract #MB1

Title: Methyltins: Sustainable Stabilizers for PVC

Authors: Richard W. Johnson, Michael B. Clark, Rohm and Haas Company

ABSTRACT

There is now a significant amount of data available on the environmental performance of methyltin stabilizers. This includes environmental and human health toxicities, as well as risk assessments that evaluate human and environmental exposures. In addition there is information about the performance of these stabilizers in PVC pipe that has been in use over 40 years. All of this information will be discussed and evaluated in terms of whether methyltin stabilizers can fulfill the requirements of being a sustainable technology.

GPEC 2006 Paper Abstract #MB3

Title: Branding is One of a Company's Most Important Assets

Author: John R Kowalski, Senior Manager, Marketing Communications

ABSTRACT

Branding is one of a company's most important assets. It's the place where corporate mission, identity and capabilities intersect, and the ability to get a brand "right" with customers can have enormous implications for the bottom line. Environmentally-aware plastics manufacturers must develop strong and versatile brands – ones that resonate in the marketplace and the environmental arena – to help differentiate their products from the competition and foster loyalty among employees and customers. Through a comprehensive brand reevaluation and implementation program, Michigan-based Cascade Engineering has strengthened its image as an innovator in plastics manufacturing. Smart branding has also helped Cascade Engineering to operate more effectively in today's challenging auto supply sector. This paper will offer useful insights into how developing a strong brand can improve a company's performance in nearly every facet of operations.

GPEC 2006 Paper Abstract #MB4

Title: Design of Business Chain for the Development and Sustainable Growth of PET Recycling in India

Author: Clement Ambros, Reliance Industries, Ltd.

ABSTRACT

The growth of PET recycling, pre or post consumer has been offset by a number of technical and non-technical hurdles, though many solutions are available. Most companies need to detour from their core business and bring about a major mind set change to initiate a strong program to implement a simple and successful recycling system.

RIL, in spite of the above, ventured into the business of recycling in the year 2002 and by 2005 became the number one recycler, recycling more than 20% of the PET bottles consumed in India. In RIL, the philosophy is that every business has to be profitable on a stand-alone basis through the proper selection of product portfolio, process, plant and machinery, location, market and raw material availability. RIL has taken the lead in converting polyester fiber waste and post consumer PET bottle waste into value added products to eliminate large volumes of polyester waste and discarded PET bottles disturbing the ecological balance.

This has been achieved through refining and modifying in-house, the prevalent recycling processes, considering the conditions of local post consumer bottle waste, application of experience and using RIL's research, testing, process engineering and design facilities in India and Germany.

RIL developed post consumer PET bottle collection, baling, sorting, grinding, and flake cleaning systems, new process and technology equipment, building on the existing platform of recycling systems, to meet the stringent requirements of RIL's quality standards. RIL created a major mind set change across the business chain for all to consider waste as a raw material and that these wastes can be made into quality products. In the business chain, RIL ensured appropriate returns to every individual involved to sustain the entire activity.

GPEC 2006 Paper Abstract #MB5

Title: PVC/Natural Fiber Composites: Back To the Future for Fun and Profit

Author: Edward Schut, CreaFill Fibers

ABSTRACT

A brief history of natural plastics is reviewed to consider the current forces in the market that mandate a re-examination of their use in various products. Potential applications for new materials will be discussed with a specific look at PVC reinforced with pulp cellulose fiber.

GPEC 2006 Student Poster Abstract #1

Title: Recycled Electronic Housings Mixed ABS Material and Flame Retardant Identification Using Near-IR and Mechanical Testing

Author: MIKE W DATTNER [mwdattner@wisc.edu]
University of Wisconsin Polymer Engineering Center

ABSTRACT

Electronics reclaimers are generating rising volumes of mixed ABS plastics from the processing of computer equipment and televisions, which represents a large market opportunity. Within our research we are investigating the processability of this scrap and the properties of the resulting material. Our prior research has shown repeatable mechanical properties. One issue that we have not addressed in the past is the presence of flame-retardants, some of which may be hazardous. To fully classify the material we have identified the individual housings materials and flame-retardants by several methods. By conducting a survey where we cataloged the weight, description, and any markings on the housings over a several week time span we have a better understanding of the percentage of ABS in the stream. Since over half of the materials by weight are not identified, we used a Near-IR spectroscope on 20 randomly selected housings to identify and catalog the materials, as well as the existence, type, and content of flame-retardants. The next step was to run mechanical tests on the 20 materials, individually and mixed, to determine if sorting of parts would provide better materials. We also addressed the impact resistance problems of recovered mixed ABS materials by adding a rubber modifier to the mixture.

GPEC 2006 Student Poster Abstract #2

Title: Development of a Respirometric System to Test Biopolymer Degradation

Author: *Thitisilp Kijchavengkul*[1], *Rafael Auras*[1], *Maria Rubino*[1], *Mathieu Ngouajio*[2], *R. Thomas Fernandez*[2]

1. School of Packaging, Packaging Building, Michigan State University
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East Lansing, MI 48824-1223

ABSTRACT

During biodegradation of biopolymers, microorganisms convert the carbon chain into biomass, water, carbon residues, and carbon dioxide gas (CO_2). Therefore, the amount of evolved CO_2 could be used as an indicator of polymers' biodegradation. To test this hypothesis, a simple respirometric system was built. This system is comprised of a humidifier, a bottle of NaOH solution to eliminate CO_2 in the air flow entering the system, bioreactors where sample or reference films were put into the soil or compost, and a CO_2 trap which was 4N NaOH solution. The amount of generated CO_2 was measured by titrating the NaOH trap with 0.4 HCl solution and using Phenolphthalein and Methyl Orange as pH indicator. This method was successful since even small amounts of CO_2 could be measured (i.e., 11.4 mg of CO_2 /day). However, there were some critical weaknesses associated with this method. First, it was labor-intensive and required to be careful. Second, from the authors' speculation, this method was based on the assumption that the NaOH trap can capture all the CO_2 gas which is not always true. And finally, there were not enough bioreactors to test multiple samples.

Consequently, an upscale and more accurate respirometric system was designed and built based on the previous prototype as shown in Figure 1. This new system has 23 bioreactors allowing 4 to 5 samples to be tested simultaneously. ASTM D5338-98 and BS ISO 14855:1999 recommend three bioreactors with a blank (only soil or compost), three with positive control films, and three with negative control films e.g. low density polyethylene. This system was designed to have better accuracy in measuring directly the amount of CO_2 evolved due to the accuracy of the gas analyzer. CO_2 free air is purged to the detector every time before measuring the CO_2 concentration of the bioreactors in order to create the zero base line. The valve switches at the manifolds, which diverts outlet air from the bioreactors to the NDIR (Non-dispersive infrared) CO_2 gas analyzer one line at a time and the switching sequence is controlled by a computer using National Instruments' Labview 7.1 software. The CO_2 concentration of each bioreactor was planned to be measured twice a day. This system integrated with Labview software could provide flexibility to the experiment by altering the programming, for example, it could be specified which bioreactors to be tested, or while the experiment is running continuously, the measured data file of CO_2 concentration of each bioreactor could be saved everyday and accessed with any kind of text editor or spreadsheet software.

GPEC 2006 Student Poster Abstract #3

Title: The Effects of Foaming Temperature, and Time on the Tensile Strength, size and Morphology of Microcellular Foam of Biomax

Author: Napawan Kositruangchai (Na), Graduate Research Assistant,
School of Packaging, Michigan State University

ABSTRACT

Environmental concerns about plastic waste have become a global issue. Presently, there is substantial interest in alternative materials such as biodegradable plastics. Biomax is a hydro/biodegradable polyester which has a potential to be used in the form of microcellular foam, consequently reducing cost. Microcellular foam is characterized by a cell size in the range of 0.1 to 10 µm, differentiating it from conventional cellular materials with cell size of about 100 µm. The unique features of microcellular foam include fine cell size, high cell density, inorganic blowing agent and no nucleation agent. The samples were prepared using a mini-extruder with injection molding into a dumbbell shape, followed by batch foaming. The effects of foaming temperature and time on the tensile strength, size and morphology of microcellular Biomax foams are being studied.

GPEC 2006 Student Poster Abstract #4

Title: Design, Synthesis and Characterization of Nano-engineered Biochemical Decontaminants

Authors: Brian Ray, Chih-ang Chang, Dilip Paul, Christopher Ibeh
Center for Nanocomposites and Multifunctional Materials [CNCMM]
Pittsburg State University, Pittsburg, KS 66762

ABSTRACT

Novel mixed metal oxide nanoparticles involving mesoporous MCM-41, 2.5%Sb-2%Cr-$SrTiO_3$ and 2%Cr-$SrTiO_3$ were synthesized using the sol-gel method, and characterized using surface area and XRD measurements. These mixed metal oxide nanoparticles were then studied using FT-IR and mass spectroscopy to explore their reactivity towards a common organic pollutant, acetaldehyde. It was found that the 2.5%Sb-2%Cr-$SrTiO_3$ and 2%Cr-$SrTiO_3$ surfaces adsorbed acetaldehyde through irreversible mechanisms involving surface hydroxyl groups. Upon exposure to ~15Torr of oxygen but in the absence of anything but minimal ambient light, no change in reaction was recorded indicating the necessity of light as an activating factor for the catalytic properties of these nanoparticles. Upon exposure to the visible spectrum, reactions resulting in acetate species were observed on both samples with some differences. It was generally found that some additional reactivity was afforded by the incorporation of a charge balancing species such as antimony. Significant addition reactivity was observed when the spectrum of incoming light was widened to include wavelengths as low as 300nm. Though the mixed metal oxides nanoparticles were originally conceived for nanocomposites formulation, these preliminary results indicate that they are viable biochemical decontaminates.