Technical Program for GPEC 2007

Plenary Speaker:

Howard Rappaport, Chemical Market Associates, Inc. (CMAI)

Bio-based and Biodegradable Materials

B1. Bioplastics: Technology Principles and Exemplars
Ramani Narayan, Dept of Chemical Eng. & Materials Science, Michigan State University

B3. PHA Natural Plastics: A Disruptive Technology for a Sustainable Future
Kristin Taylor & Marcia Miller, Metabolix

B5. Ecobionanocomposites: A new class of green materials
John R. Dorgan, Birgit Braun, Chemical Eng Dept, Colorado School of Mines, & Andrew Young, Laura O Hollingsworth, PolyNEW Inc.

B6. Designing for Environment with Compostable Materials
Steve Mojo, Biodegradable Products Institute

B7. Vehicle Sound Package Designed with eco - Bio based friendly products
Hameed Khan, Rieter USA & Aurélie Boyer and Jean Casulli, Rieter France

B8. Material Design of High-Performance Molecular Composites Composed of Cellulose Derivatives
Masayuki Yamaguchi and Kenji Masuzawa, School of Materials Science, Japan Advanced Institute of Science and Technology

B9. High Performance Engineering Polymers Made with Renewable Resources
Dr. Joseph V. Kurian, DuPont Company

B10. Assessment of Biodegradable Mulch Films in Tomato Plots
Thitisilp Kijchavengkul, Rafael Auras & Maria Rubino, School of Packaging, Michigan State Univ. & Mathieu Ngouajio, Rodney T Fernandez, Dept of Horticulture, Michigan State University

B11. Development of New Biodegradable Materials via Blends for Marine & Naval Application
Christopher C. Ibeh, Ctr for Nanocomposites & Multifunctional Materials, Pittsburg State University

B12. Preparation and Characterization of a Completely Biodegradable Soy Protein Based Composite
Xiaosong Huang, Fiber Science Program, Cornell University

B14. Bamboo Fiber Reinforced Eco-Composites by Wetlay Processing
Wei Zhang, Hailing Yang, Ronald Moffitt Advanced & Applied Polymer Processing Institute for Advanced Learning & Research

B15. The Impact Of Processing Aids on PLA Extrusion Performance
Edward L. Steward, American Kuhne Corporation

B16. Titanate and Zirconate Coupling Agents – A Key to Environmental Innovation
Salvatore J. Monte, Kenrich Petrochemicals, Inc.

B17. Natural Fiber Options for Economic, Durable and Structural Plastics Composites
Edward Schut, Creafill

Reclamation & Supply

RS1. Reclamation and Recycling of Thermoset Composites
Wolfgang Unger, Seawolf Industries

RS2. Plastic Film Recycling—Sustainability through Closed Loop Recycling
Daniel Schrager, NextLife

RS3. Plastics Waste and Recycling, A Lost Paradise
Anton John Hartomo, CReTi / PTDI & IPN – Indonesia

RS4. Initiatives by Plants Around The World Focused on Landfill Reduction and Internal Reuse
Vince Herran, Sealed Air Corporation

RS5. Toughened Composites from Ground Tires
M.L Leyva, IPR/UERJ

RS6. Reuse of TP Face Fibers
Bob Peoples, Carpet & Rug Institute

RS7. Adding Value to Recycled PET Flakes
Girish Bhatt, Bepex International LLC

RS8. Achieving Sustainability with Reusable Transport Packaging
Fred Hepinstall, RPCC Vice-President

RS10. Processing of the Composite LDPE/Al from Carton Packages and it's Modification with Wood Fibers
Mario Henrique De Cerqueira, Tetra Pak Ltda.

RS11. Thermoplastic Separation and Recovery for Various Mixed Scrap Plastics by the Argonne Developed Froth Flotation Technology
J.A. Pomykala, Jr., B.J. Jody, and E.J. Daniels, Argonne National Laboratory

RS13. Size Reduction for Effective Reclamation
John Farney, Cumberland Engineering & Keith Larson, Colortronic North America

RS12. Film Scrap Recycling/Reclaim Options
Dana Darley, Extrusion Auxiliary Services, Inc.

RS21. Closed Loop Recycling of HDPE Milk Bottles From Post Consumer Waste Back to Food Contact Grade
Edward Kosior and Rob Dvorak, NEXTEK Ltd.

RS15. Processing of non-dried PET-Bottle-Scrap using Co-rotating Twin Screw Extruders
Paul Andersen, Coperion & Sabine Schönfeld, Coperion Werner & Pfleiderer, Germany

RS16. Polymer Filtration Options for Plastics Recycling
Dan Smith, PSI

RS17. Post Consumer Resins and the Road Ahead
Michael Schedler, NAPCOR

RS14. Material Handling Considerations for Reclaim Extrusion
Keith Larson, Colortronic North America

RS18. FDA Approved Pet Polymers Containing PCR Recycled Content
Jeffery Best, Invista

RS19. The Most Environmentally Friendly Barrier Enhancement for PET Bottles
Peter K. Andrich, SIG Beverages North America Inc.

RS20. Celstran Recycling Concept-Incorporation of LFT Production Scrap Into Celstran Pultrudate
Gabi Thomas, Heinz Bernd, Ticona

Recycling: Automotive

RA1. Moving Toward Sustainable Plastics 2006/7 Report Card of Leading Automakers
Jeff Gearhart, Charles Griffith, Claudette Juska – Ecology Center

RA2. A Study on Recycling Plastic Materials in Heavy Trucks
Srikant Ghantae & Noelie Paperella, Volvo 3P

RA3. Alternatives to Chrome Plating and Related Chemical Use in Creating Automobile, Light Truck, and Heavy Truck Decorative Components
Gordon C. Miller, M.,M.,&A., LLC

RA4. 100% Environmentally Friendly Surface Treatment Process
Simon Brynolf, FTS Technologies

RA5. Mixing PC/ABS Regrind: A Preliminary Study
Ewa Lebert & Susan Kozora, Visteon Corporation

RA6. Converting Post Consumer Recycle PET Waste into PBT Based Engineering Thermoplastics for Automotive and Electrical Applications
Dhaval Shah, GE Plastics

Recycling: General

RG1. Anhydride Functional Ethylene Copolymers as Compatibilizers for Polyethylene Rich Mixed Recycle Streams,
Gregg B. Babcock and David M. Dean, DuPont

RG2. Chemical recycling of PET wastes in powder form
Behzad Shirkavand Hadavand, Iran Polymer and Petrochemical Institute &
Hossein Hosseini, Islamic Abadan Azad University

RG4. Microcellular Recycled PET Foams for Food Packaging
Dr. Vipin Kumar & Krishna V. Nadella, Dept of Mechanical Eng, Univ. of Washington
& Greg L. Branch, MicroGREEN Polymers, Inc.

RG3. PVC Recovery and Recycling in Europe - Part 1
Sascha Schuh, ASCON GmbH

RG3. PVC Recovery and Recycling in Europe – Part 2
Sascha Schuh, ASCON GmbH

RG8. How to Structure, Finance, And Fund Your Clean Technology Venture: Start-Ups, Corporate Governance, Venture Capital, Strategic Alliances, & Private Equity in a 'Green' Marketplace
Eric Koester, Esq., Heller Ehrman LLP

RG5. Compatibilizers for Recycle Products
Bill Sigworth, Chemtura Corporation

RG7. Resource Productivity and Sustainable Growth: Applying nature's principles to extend a material's DNA to its next life
Dr. Seetha Coleman-Kammula, NextLife LLC

RG6. Characterization of Post-Consumer Plastic mixtures Compatibilized by Block Copolymers
Sarah Bobek, Aniket Selarka, Ned V. Gvozdic and Charles L. Beatty,
University of Florida

Recycling: Electronics

RE1. MSS e-Sort™ Automated Optical Sorting of Electronic Scrap
Felix A. Hottenstein, MSS, Inc. Nashville, TN

RE2. Utilizing Due Diligence to Minimize RoHS Risks
George J. Fechtmann, PE, Underwriters Laboratories (UL)

RE3. RoHS and WEEE and How it Has Affected Our Designs for Process Controls for the Plastics Industry
Thomas Linehan, D-M-E Company

RE4. Recycling ABS from End-of-Life Electronics into Wood-Plastic Composites
Shu-Kai Yeh, Sushant Agarwal & Rakesh K. Gupta, Dept. of Chem. Engineering, West Virginia Univerity

RE5. Material Recycling of a Mixture of Residual Plastics from Waste Household Appliances
Yuichi Matsuo, Mitsubishi Electric Co. Ltd.

Recycling: Regulatory

RR1. Flame Retardants: Fire Safety, Regulatory Status & Current Issues
Raymond B. Dawson & Susan D. Landry, Albemarle Corporation

RR2. Greenguard Certification-Goods with Low Chemical & Particle Emissions for Indoor Use
Bob Young, Eastman Chemical

RR3. New Developments in Plastics Identification Technology Open New Ways In Plastics Recycling
Peter Mayer, S+S Separation and Sorting Technology GmbH

Student Posters

GPEC 2007 Student Poster Abstract #1

Title: Development of Biodegradable Polylactide / Nanoporous Zeolite Composites
Authors: Isinay E. Yuzay, Rafael Auras, Susan Selke *School of Packaging, Michigan State University

GPEC 2007 Student Poster Abstract #2

Title: Rheological & Degradation Properties of Renewable Resource Polymer Blends based upon Poly-hydroxyalkanoates and Poly-lactide
Authors: Jason D. Conrad, James P. Eickhoff, and Graham M. Harrison, Department of Chemical & Biomolecular Engineering and Center for Advanced Engineering Fibers & Films Clemson University

GPEC 2007 Student Poster Abstract #3

Title: Mechanical Behavior of Poly(ethylene Terephthalate) Fibers Processed with Vapor Grown Carbon Nanofibers (VGCNFs)
Authors: Rodney D. Averett and Mary L. Realff, Ph.D., School of Polymer, Textile, and Fiber Engineering, Georgia Institute of Technology

GPEC 2007 Student Poster Abstract #4

Title: Advantage of Material-recycle for Polypropylene with Nanofibers
Authors: Miwa Tenma and Masayuki Yamaguchi, Japan Advanced Institute of Science and Technology

GPEC 2007 Student Poster Abstract #5

Title: Enhancement of Melt Elasticity by Addition of Critical Gel for Biomass-based Plastics
Authors: Keiichi Arakawa and Masayuki Yamaguchi, Japan Advanced Institute of Science and Technology

GPEC 2007 Student Poster Abstract #6

Title: Effects of Injection-Molding on Polylactide Properties
Author: Richard Haibach, Plastics Engineering Department
Penn State University at Erie, The Behrend College

GPEC 2007 Student Poster Abstract #7

Title: Packaging Sustainability: Life Cycle Assessment of PLA, PET & PS
Authors: Santosh Madival[1], Rafael Auras[1]*, Sher Paul Singh[1], Ramani Narayan[2]
1. School of Packaging, Packaging Building, Michigan State University
2. Department of Chemical Engineering, Michigan State University

GPEC 2007 Student Poster Abstract #8

Title: Recovery of Caprolactam from Nylon 6 by Catalytic Depolymerization in the Melt
Authors: Valli Subbiah, Georgia Institute of Technology, School of Chemical and Bio-molecular Engineering and Latoya Bryson, Georgia Institute of Technology, School of Chemical and Bio-molecular Engineering

GPEC 2007 Paper Abstract #B1

Title: Bioplastics: Technology Principles and Exemplars

Author: Ramani Narayan (narayan@msu.edu)Dept of Chemical Engineering &
Materials Science Michigan State University

ABSTRACT

Biobased plastics hold great promise for achieving the goals of sustainable development and implementing the principles of industrial ecology. These bioplastics offer value in the sustainability/life-cycle equation by being part of the biological carbon cycle. This global carbon cycle vis-à-vis managing carbon efficiently and in an environmentally responsible manner will be discussed. Identification and quantification of biobased content uses radioactive C-14 signature. Life Cycle Assessment (LCAs) of these bioplastics often show reduced environmental impact and energy use when compared to plastics based solely on petroleum feedstocks.

Biopolymers are synthesized by many types of living matter - plants, animals, and bacteria - and are an integral part of ecosystem function. Because they are synthesized by living matter, biopolymers are generally capable of being utilized by living matter (biodegraded), and so can be disposed in safe and ecologically sound ways through processes like composting, soil application, and biological wastewater treatment. Single use, short-life, disposable products can be engineered to be biobased and biodegradable. Biodegradability requires complete assimilation of the plastic by the microbial populations present in the selected disposal environment in a defined time frame as opposed to degradable or partially biodegradable. Therefore, biobased content and biodegradability are essential elements for single use, short-life disposable packaging and consumer plastics. For durable, long life articles bioplastics needs to be engineered for long-life and performance, so biodegradability may not be an essential criterion.

There are two basic routes to manufacture bioplastics. Direct extraction from biomass yields a series of natural polymer materials like cellulose, starch, proteins, fibers, and vegetable oils that can form the platform on which plastic products can be developed. Alternatively, the renewable resources/biomass feedstock can be converted to bio-monomers by fermentation or hydrolysis and then further converted by chemical synthesis to bioplastics like polylactic acid. Bio-monomers can also be microbially transformed to biopolymers like the polyhydroxyalkanoates plastics. Vegetable oils offer another important carbon platform to polyols (precursors for polyurethanes, polyesters) and other functional monomers/macromers.

Bioplastics will play an increasingly important role in a society moving towards a sustainable and environmentally responsible materials base. This presentation captures the principles of bioplastics technology and showcases technological and commercial successes of bioplastics.

www.msu.edu/user/narayan
www.ktmindustries.com; www.ecosynthetix.com
www.bioplasticpolymers.com; www.bpiworld.org

GPEC 2007 Paper Abstract #B3

Title: PHA Natural Plastics: A Disruptive Technology for a Sustainable Future

Authors: Kristin Taylor & Marcia Miller, Metabolix

ABSTRACT

Metabolix is commercializing a family of polymers (PHA natural plastics) made from renewable resources such as corn sugar and vegetable oils. Within the foreseeable future, this technology will also enable the production of these Natural Plastics directly in non-food plant crops. These high performing new materials have the potential to put a large portion of the plastics and chemicals industry on a sustainable basis. Metabolix's Natural Plastics range in properties from rigid, strong and stiff to tough and highly elastomeric to soft and tacky. They can be made as resins or aqueous dispersions with excellent film forming characteristics. Robust in use, yet biodegradable, they offer a renewable and environmentally friendly alternative in many applications now served by synthetic plastics, including fiber, film, molded goods, extruded products, adhesives, and coatings.

In November 2004, Metabolix formed an alliance for the production of its Natural Plastics via fermentation with Archer Daniel Midland, one of the world's largest producers of agricultural products. ADM recently announced the building of the first production plant to be located in Clinton, Iowa. Metabolix is progressing its second platform technology, the production of PHA natural plastics in non-food crop plants. In June 2005, Metabolix was honored by the receipt of the 2005 Presidential Green Chemistry Challenge Award for its development of Natural Plastics and recently received an Environmental Award from the Society of Plastics Engineers.

GPEC 2007 Paper Abstract #B5

Title: Ecobionanocomposites: A new class of green materials

Authors: John R. Dorgan, Birgit Braun, Chemical Eng Dept, Colorado School of Mines, & Andrew Young, Laura O Hollingsworth, PolyNEW Inc

ABSTRACT

Ecological concerns are a predominant theme for the 21st century; humanity must develop sustainable systems for materials and fuels. Biologically derived and inspired materials offer hope for achieving this important goal. Also, nanotechnology is rapidly expanding and its convergence with both biology and ecology is now being recognized. Ecobionanocomposites are a new class of green materials that exploit this triple convergence of technologies.

Polylactide (PLA) nanocomposites are representative of these new green materials. PLA is derived from renewable resources utilizing biotechnology and is an ecologically attractive alternative to increasingly expensive petroleum based plastics. Similarly, cellulose is a natural biological polymer with a host of important properties including structural hierarchy at the nanoscale. A novel approach towards nanocomposites using hydroxyl groups on the surface of cellulose fibers to initiate the polymerization reaction of lactide is reported. It is demonstrated that the use of reactive compatibilization offers unique opportunities in creating new and value added ecobionanocomposites.

GPEC 2007 Paper Abstract #B6

Title: Designing for Environment with Compostable Materials

Author: Steve Mojo, Biodegradable Products Institute

ABSTRACT

Biodegradable plastics have been under development for the past 15 years. Originally, their use in packaging was seen as the solution to many of our solid waste problems. However, this view changed as consumers, customers and composters were disappointed by the performance of the initial versions of these new materials. In response to the feedback from customers and others, manufacturers have been developing and are now marketing a new class of biodegradable plastics, which can be used in packaging and meet stringent ASTM standards.

The presentation will cover

- A brief overview on the development of biodegradable plastics and the resulting consumer response.
- The development of the current ASTM standards and their application.
- The certification programs and what is happening with these programs in Europe, the US and Japan.
- Examples of recent programs where biodegradable plastics have played a critical role in diverting organic materials from landfills and incinerators.
- Guidelines for designing with this new class of materials.

The Biodegradable Products Institute is a multi-stakeholder association of key individuals and groups from government, industry and academia, which promotes the use, and recycling of biodegradable polymeric materials (via composting). BPI will accomplish this goal with three key components.

*Education
*Adoption of Scientifically Based Standards
*Alliances and Harmonization with Organizations and Standards

GPEC 2007 Paper Abstract #B7

Title: Vehicle Sound Package Designed with eco - Bio based friendly products

Authors: Hameed Khan, Rieter USA & Aurélie Boyer and Jean Casulli, Rieter France

ABSTRACT

- State of the art concerning actual sound package technologies+ European/American standards which push car manufacturer so Tier 1 to increase % of 'bio' components
- What is done and/or can be done in a short term; Example: to increase the use natural fibres into our felts and use of hemp fibres in replacement of glass fibres into injected parts
- How to reach the use of 'bio' products in keeping the properties of product following the customer specifications?
- What can be done with the implication of the car manufacturer; example: Kenaf for VW

GPEC 2007 Paper Abstract #B8

Title: Material Design of High-Performance Molecular Composites Composed of Cellulose Derivatives

Authors: Masayuki Yamaguchi and Kenji Masuzawa, School of Materials Science, Japan Advanced Institute of Science and Technology

ABSTRACT

Cellulose acetate propionate is employed to develop high performance materials by molecular composites with other polymeric materials. In this presentation, a transparent polymer blend with a rubbery material is shown firstly. Although the blend has phase-separated morphology, light scattering due to phase-separation is depressed because of the mutual dissolution of both components to some degree. Further, the mechanical toughness, which is one of the serious problems for cellulose-derivatives, is considerably improved to a great extent. Secondly, a new type of polymers with no birefringence is developed by the molecular composite technique. Since various properties are similar to cellulose triacetate, which is employed as a cover-film of polarizer, the composites will be employed in the field of the optical film by extrusion processing.

GPEC 2007 Paper Abstract #B9

Title: High Performance Engineering Polymers Made with Renewable Resources

Author: Dr. Joseph V. Kurian, DuPont Company

ABSTRACT

DuPont Engineering Polymers is moving forward with plans to produce a new family of high-performance thermoplastic resins and elastomer products made with renewable resources. The new products are DuPont™ Sorona® polymer and DuPont™ Hytrel® made with renewable resources. The key ingredient in Sorona® polymer is Bio-PDO™, which is derived from corn sugar using a proprietary fermentation process. DuPont™ Hytrel® polymer made with renewable resources will be produced using a 100% bio-derived DuPont polyol™, Cerenol™, made with Bio-PDO™. DuPont/Tate & Lyle Bioproducts LLC, a joint venture between DuPont and Tate & Lyle, started the first large-scale industrial production of Bio-PDO™ at the Loudon, TN facility in 2006. From a cradle-to-gate perspective, the production of Bio-PDO™ consumes 40% less energy and reduces green house gas emissions by 20% versus petroleum-based 1,3-propanediol. Production of 100 million pounds of Bio-PDO™ in the Loudon plant will save the equivalent of 10 million gallons of gasoline per year. The performance and processing characteristics of both Sorona® and Hytrel® made with renewable resources are as good as or better than those of current products made wholly from petrochemicals. This presentation will provide an overview of the Bio Based Materials Technology Platform, polymer properties, commercialization status and applications of these polymers. More information can be found at our web site: http://www.dupont.com/sorona

GPEC 2007 Paper Abstract #B10

Title: Assessment of Biodegradable Mulch Films in Tomato Plots

Authors: Thitisilp Kijchavengkul, Rafael Auras & Maria Rubino, School of Packaging, Michigan State University & Mathieu Ngouajio, Rodney T Fernandez, Dept of Horticulture, Michigan State University

ABSTRACT

Plasticulture, the production of fresh produce on beds covered with plastic mulch films and irrigated by drip, has become a standard for growers in the U.S. and around the world. For example, in 1999, more than 30 million acres (185,000 acres in the U.S.) were covered with plastic mulch, and these numbers are increasing dramatically due to plasticulture's multiple advantages. This production technique can provide higher yields, increased produce quality, reduced weed infestation, decreases in disease incidence, and increased efficiency in water and fertilizers' usage. However, there are still some disadvantages with plasticulture, including the costs of removal and disposal of the used plastics and environmental concerns, since most of the used mulch ends up in landfills. To solve these problems, the use of mulch films from biodegradable polymers obtained from renewable sources seems to be a promising solution because the films can degrade right at the field, the costs of removal and disposal are reduced, and the amount of waste ending up in landfills is cut down.

The objective of this work was to study the use of biodegradable films in agricultural applications. Three biodegradable mulch films, two made from biodegradable polyester blends of different thickness and color (black or white) and a conventional low density polyethylene (LDPE) mulch film, were used to cover the beds of tomato plots in the state of Michigan during the months of May through September. Changes in the physical appearance of the films and tomato plants were observed and recorded every week with a digital camera. Every two weeks, film samples were taken from the plots, and their mechanical, optical, and physical properties were characterized. Once tomato harvests were done, the conventional LDPE mulch films were removed and all the tomato plants were cut. After that, all the biodegradable mulch films were plowed into the soil. The changes of the films were visually observed, and the film samples after plowing were characterized according to the properties mentioned. This paper describes the results obtained during one season of testing.

GPEC 2007 Paper Abstract #B11

Title: Development of New Biodegradable Materials via Blends For Marine & Naval Application

Author: Christopher C. Ibeh, Center for Nanocomposites & Multifunctional Materials, Pittsburg State University

ABSTRACT

This project involves the design, formulation, development and characterization of new biodegradable materials via blends of four major raw biomaterials, polytetramethylene adipate-co-terephthalate, polycaprolactone [PCL], propylene glycol [PEG] and hydroxyl propyl cellulose. Pre-selection of the basic biomaterials is based on such criteria as solubility parameter, potential for biodegradability, biocompatibility, processability, low temperature properties, and cost-effectiveness. Produced blends exhibit thermal transition profiles [single melt temperatures (53 – 54 ^{o}C] different from those of blend components [60 – 120+ ^{o}C]. The single melt temperatures of the blends indicate that they are unique, new materials. Biodegradability of the blends is established via in vitro tests per ASTM F 1635-85 protocol. Preliminary results of the in vitro tests show that the blends' biodegradability is PEG-controlled. Current efforts involve infusion of the developed biomaterials with nanoparticles for mechanical properties enhancement without compromising biodegradability.

GPEC 2007 Paper Abstract #B12

Title: Preparation and Characterization of a Completely Biodegradable Soy Protein Based Composite

Author: Xiaosong Huang, Fiber Science Program, Cornell University

ABSTRACT

In this research, fully biodegradable 'green' composites were fabricated using a modified soy protein concentrate (SPC) resin and flax fibers. The modified SPC resin was prepared by blending SPC with nano-clay particles, and then being modified by glutaraldehyde (GA). The modified SPC showed significantly improved mechanical properties. Flax fiber was used as the reinforcement, in yarn form, for fabricating environmentally friendly composites with the modified SPC resin as the matrix. The unidirectional flax yarn reinforced SPC composites showed a longitudinal tensile strength of 308 MPa and a modulus of 4.3 GPa. They also exhibited an excellent flexural property in the longitudinal direction. The flexural stress was 119 MPa and the flexural modulus was 9.8 GPa.

GPEC 2007 Paper Abstract #B14

Title: Bamboo Fiber Reinforced Eco-Composites by Wetlay Processing

Authors: Wei Zhang, Hailing Yang, Ronald Moffitt Advanced & Applied Polymer Processing Institute for Advanced, Learning & Research

ABSTRACT

Hammer-mill processed bamboo fibers were used as the reinforcement fiber for an eco-composite made from wetlaid non-woven mat using polyester fibers as the binding fibers. These eco-composites containing up to 70 wt% bamboo fibers were compression molded and tested using 3-point-bending and tensile tests. The crystallization behavior of the polyester in the matrix was analyzed using a DSC. These results were compared with those of composites made from melt processing. The optimal fiber compositions, processing technologies and the compression molding conditions such as temperature, pressure and time have been determined.

GPEC 2007 Paper Abstract #B15

Title: The Impact Of Processing Aids on PLA Extrusion Performance

Author: Edward L. Steward, American Kuhne Corporation

ABSTRACT

The interest in extruding PLA (Polylactide resin) is growing for several reasons. These include the fact that the polymer comes from a renewable resource and that it is a degradable material. Marketability of disposable products is certainly enhanced by either factor.

This paper will give the results of a data collection effort on a single screw extruder that was designed to determine optimum screw design and processing conditions for PLA with and without a processing enhancement additive. The data was developed on a large enough machine to allow accurate scaling to common production extruder sizes that this polymer would be considered for use.

GPEC 2007 Paper Abstract #B16

Title: Titanate and Zirconate Coupling Agents – A Key to Environmental Innovation

Author: Salvatore J. Monte, Kenrich Petrochemicals, Inc.

ABSTRACT

Titanate and zirconate coupling agents continue to be a dynamic arena for dramatic changes often causing a new paradigm in polymer applications technology. For example, an ACS CAS search for *Ti or Zr coupling agents* for the 15-month period May 25, 2004 to September 2, 2005 generated two hundred and thirty nine *patent and technical paper/article* abstracts – seventeen of which involved nanocomposites. In addition, an ACS CAS search for *Ti or Zr coupling agents* for the 9-month period September 3, 2005 to May 31, 2006 generated 169 abstracts – 22 of which involved nanocomposites – 67% of these Nano abstracts were by investigators from China. Some of the significant abstracts will be used to teach the Six Functions of the Titanate Molecule and their application in innovative environmental applications such as recycling and sustainable composites.

The GPEC 2007 paper will address some of the more interesting developments:

- Abstracted work by others will be highlighted such as the use of a pyrophosphato titanate treated nanoclay and functionalized elastomer components to increase the impact strength and mechanical properties of filled Polyhydroxybutyrate (PHB – a biodegradable and sustainable bioplastic from renewable resources). Also, a pyrophosphato titanate proves was shown to be useful to mold biodegradable hydrophobic starch filled PVA compositions.
- Organic interfaces such as flax and kraft paper fiber and carbon are shown to be dispersible – even in the water phase. Cellulose nanofibers extracted from agricultural residues loaded at 5-10% wt in PLA and starch composites is being investigated.
- Wood fiber composite decking tiles utilizing pyrophosphato titanate and recycled polyolefins as supplied by Integrated Composites Technologies, Inc. will be shown. Wood fiber filled polyolefin extrudates produced by Andersen using maleated PP and titanate will be discussed.
- In situ metallocene-like copolymerization catalysis of dissimilar thermoplastics results in new copolymers. For example, when a LDPE/PP-50/50 blend undergoes six thermal cycles in a twin screw, the melt index of the control climbs from 17 to 38 while 2 parts per thousand of a phosphato titanate lowers chain scissoring to a 23 melt index. New recycle and increased regrind applications are possible. For example, an injection molder was able to work off PP recycle into normally 100% HDPE parts using a pelletized masterbatch of a pyrophosphato titanate.
- Information will be updated for the GPEC presentation.

GPEC 2007 Paper Abstract #B17

Title: Natural Fiber Options for Economic, Durable and Structural Plastics Composites

Author: Edward Schut, Creafill

ABSTRACT

The concept of incorporating natural fibers into a plastic matrix is not a new one. In fact since their inception synthetic plastic polymers have used natural reinforcing material as a way to improve physical properties while reducing cost and density. By examining some of these historical composites, their applications and benefits, we can better understand the factors that will shape the future of natural fiber plastic composites today.

A very promising material from both an economic and performance point of view is combining post consumer paper and virgin pulp fiber in thermoplastic polymers. This presentation gives a detailed account of the economics, performance and durability of these composites as well as examples of “real world” product development.

GPEC 2007 Paper Abstract #RS1

Title: Reclamation and Recycling of Thermoset Composites

Author: Wolfgang Unger, Seawolf Industries

ABSTRACT

This paper will review how recycled FRP can be used in the construction of boats, spas, bathtubs, automobile and truck parts, flat and corrugated panels, container floors, and almost any large part product manufacturing using fiberglass and present uses are……..

1. Seacast is recycled fiberglass for wood replacement in boats. This has been successfully marketed for 20 years.
2. Using recycled fiberglass to replace between 40% and 100% of new fiberglass reinforcement. Three systems are in use (Brazil, Europe and USA) since early 2006 and three systems will be installed in the next four months (Australia, USA and Canada).

This paper will demonstrate the cost and energy savings, as well as the improvement of physicals.

GPEC 2007 Paper Abstract #RS2

Title: Plastic Film Recycling—Sustainability through Closed Loop Recycling

Author: Daniel Schrager, NextLife

ABSTRACT

Plastic film recycling has the potential to be the next recycling success story. Packaging and durable goods manufacturers, retailers and grocers, Fortune 500 companies, municipalities and other waste generators are starting to realize the benefits of recycling plastic films. Too few companies are aware that their plastic film waste is not only an economic resource but a strategic one. The key to acceptance will be a shift in the mindset of executives to understand that this material is not *garbage*, not just a *recyclable material*, but a *renewable resource* that can play a significant role in achieving a company's economic, strategic and environmental goals. This presentation will explain the added benefits of a closed-loop recycling program in achieving long-term sustainability.

Other topics of discussion will cover:

1. State-of-the-art recycling and manufacturing technologies
2. Post-consumer plastic films become PCR resins and renewable resources
3. Developing diversified markets helps to create long term consistent recycling programs
4. Selling PCR to product manufacturers who can use them to produce long-lasting durable products that wont go right back into the waste stream
5. Example of a closed loop recycling program for major retailers transform their scrap into new products on their shelves

GPEC 2007 Paper Abstract #RS3

Title: Plastics Waste and Recycling, A Lost Paradise

Author: Anton John Hartomo, CReTi / PTDI & IPN – Indonesia

ABSTRACT

Global Plastics Environmental Conference
Environmental Innovation : Plastics Recycling & Sustainability
Society of Plastics Engineers, Environmental Division
March 6-7, 2007, Orlando – Florida, USA

PLASTICS WASTE AND RECYCLING, A LOST PARADISE

Indonesian Scene *vs* Global Perspective

Yafet Samuel Prayitno, **PTDI / CReTi**– Center for Recycling Technology – Bandung – West Java
Anton John Hartomo, **PTDI / CReTi & IPN** / Indonesian Polytech Network *)

ABSTRACT

Recent significant growth of demand for plastics recyclables encourages many facets of proper solid waste disposal-management, capacity of adequate technology of strong scientific support, accurate mapping of related potentiality of actual zones, network of collectors and recyclers, standards, regulation and certificating bodies. Informal even illegal activities are currently still prevalent and prominent in Indonesia, with extremely low attention to quality, safety, health and environmental (SHE) impacts.

Bigger challenge than ever are, amongst others : rapid and extensive dissemination of technological development and exchange, mitigation of negative impacts on SHE, rationalization of practices and barriers to related activities, networks and integration among players, and strategies for implementing sound measures to strengthening our national capabilities. Comparison to China, Indo-China, India, and other ASEAN countries are explained.

Fact-sheet of plastics recycling praxis in Indonesia, process and product quality improvements provided and stewarded by PTDI (CReTi) – Centre for Recycling Technology, Indonesia - from either chemical, rheological, and processing angles, as exemplified by implementing the PLASTOMIX-PLASTIMAX technology, as well as the cultural, economic, and legal aspects, will be described. Collaboration among players, related community authorities, professional organizations (local/regional/global), also from govermental bodies, are being road-mapped and developed. Networking and synergy with professional organizations such as SPE abroad are highly encouraged.

*) *to whom correspondence should be addressed.* Previously lecturer at ITS Surabaya (80s), managing Chandra Asri Petrochemical Center CAPC (90s), currently after retired he is chairing PTDI/CReTi and presiding IPN.
See Who's Who in Science and Engineering, Marquis, 2003 - 2007
eMail : **antonhartomo@yahoo.com**, **plastomix_ptdi@yahoo.com**

GPEC 2007 Paper Abstract #RS4

Title: Initiatives by plants around the world focused on landfill reduction and internal reuse

Author: Vince Herran, Sealed Air Corporation

ABSTRACT

As part of our strategic corporate initiatives, the worldwide plastic recycling program has come under our "Make a Difference" initiative and received strong corporate commitment and support. This promoted finding new methods of reprocessing and new applications for our reclaimed plastic material. Sealed Air has traditionally been a leader in the efficient use of plastic raw materials. The Company's environmental initiatives encompass a number of aspects including reduced waste, source reduction, energy conservation and yield improvement projects. Many of the scrap materials that cannot be eliminated through these projects are recycled within the facility, at other Sealed Air locations and by outside companies. Through recent focus in this area, the Company has increased its reuse and recycling rates significantly in recent years. For example, more than 130 million pounds of scrap plastic are now recycled or reused annually.

Before its acquisition of the Cryovac Division in 1998, nearly all Sealed Air facilities could internally re-use scrap plastics generated during the manufacturing processes. In fact, Sealed Air uses a significant percentage of post-industrial scrap in many of its products. The Cryovac Division's focus in food packaging products prevented it from being able to match that reuse/recycle standard. However, since the traditional Cryovac branded products now make up a large percentage of Sealed Air's products and sales, it was important that the Company renew its efforts to reuse and recycle all of its plastic waste streams.

The "Make a Difference" recycling initiatives have yielded significant results. Since 2003, this coordinated effort has resulted in a 50% increase in the reuse and recycle rate of scrap plastic and a 34% reduction in the landfill rate for Sealed Air. Through the efforts of a new plastics recycling center in North America and new recycling equipment throughout the world, reuse of plastic scrap into existing food packaging and shrink packaging products grew by over 200% in 2005 over 2003. The ongoing effort to minimize landfill and to seek value-added options for plastic scrap disposal will continue to provide additional benefits to the Company for years to come. A new environmental metric system allows us to better measure progress toward higher material utilization goals globally.

Sealed Air embarked on a coordinated effort to significantly improve our ability to reuse and recycle plastic waste streams that often ended up being landfilled. The Company committed full time positions to coordinate efforts to locate reliable and sustainable options to reprocess scrap materials from the food packaging and shrink packaging businesses on a global basis. With the help of existing plant and R&D resources, the World Class Manufacturing team and existing

environmental staff personnel, this effort has resulted in tremendous progress globally. Separately, the corporate environmental department has recently developed a global database for collecting environmental metrics from each facility around the world. This reporting tool has allowed the Company to measure and encourage progress in these renewed recycling efforts. Sealed Air's food packaging segment's Global Manufacturing Leadership Team has used reports from this database to focus additional attention on reuse or sale of scrap plastic and to garner support from the manufacturing facilities.

GPEC 2007 Paper Abstract #RS5

Title: Toughened Composites from Ground Tires

Author: M.L Leyva, IPR/UERJ

A**BSTRACT**

No abstract currently available.

GPEC 2007 Paper Abstract #RS6

Title: Reuse of TP Face Fibers

Author: Bob Peoples, Carpet & Rug Institute

ABSTRACT

No abstract currently available.

GPEC 2007 Paper Abstract #RS7

Title: Adding Value to Recycled PET Flakes

Author: Girish Bhatt, Bepex International LLC

ABSTRACT

Post consumer PET bottles are normally recycled for textiles (or garments), carpets, sheets and injected molded goods. The bottle-grade PET is of a higher quality and has better performance characteristics relative to other grades of PET. It is important to recover its value to produce high performance PET products. The value of PET flakes can be further enhanced by Solid State Polymerization (SSP). The SSP process increases the degree of polymerization of the flakes (expressed as intrinsic viscosity –IV) while removing several contaminants resulting in enhanced performance characteristics of the recycled PET. The recycled PET flakes, after being processed through the SSP system, can be directly converted to high quality industrial and construction materials as well as PET bottles that require a higher than normal I.V. A unique continuous process is presented here which is energy efficient and suitable for integration into large scale upstream reclamation facilities and downstream extrusion operations.

GPEC 2007 Paper Abstract #RS8

Title: Achieving Sustainability with Reusable Transport Packaging

Author: Fred Hepinstall, RPCC Vice-President

ABSTRACT

As companies strive for sustainability, reusable packaging moves their product throughout the supply chain quickly, safely and cost-effectively. Reusable packaging is designed for continuous trips throughout the supply chain and is available in a wide variety of forms (boxes, trays, pallets, etc) and materials (plastic, steel, etc.)

How does reusable packaging impact the three tenets of sustainability?

- Economic: It reduces overall packaging costs over the life of the packaging, with a rapid return on investment. Reusable packaging enables consistent, repeatable trips through the supply chain to ensure system continuity.
- Social: It is designed to be recycled at the end of its service life, when it can be recovered and reprocessed into other useful products.
- Environmental: It prevents waste associated with single-use packaging from entering the solid waste stream and reduces greenhouse gas emissions and total energy use.

Key Learning Points:

In this session, attendees can expect to:

- Receive a brief overview of reusable packaging products/services and their impact all along the supply chain.
- Learn how reusable packaging impacts the three tenets of sustainability: social, environmental and economic (real life examples, etc.)
- Learn how to get started in implementing a reusable packaging program.

GPEC 2007 Paper Abstract #RS10

Title: Processing of the composite LDPE/Al from carton packages and its modification with Wood Fibers

Authors: Mario Henrique De Cerqueira, Tetra Pak Ltda. & J.A.M. Agnelli,
Universidade Fédéral de Sao Carlos, Department of Material Engineering

ABSTRACT

The urban solid waste problem has been one of the biggest environmental challenges these days. The solution to this problem lies in integrated waste management, the objective is to minimize volumes sent to landfills. Recycling is a big part of this waste management process which involves the reprocessing of materials to obtain alternative uses for these materials in every day live.

One of the solid waste materials sent for recycling is the carton package, which is made of paper, polyethylene and aluminum.

In conjunction with this, the search for new plastics compounds reinforced with cellulose fibers has been appointed as a market demand thanks to the high number of possible applications of these materials, for instance in the car manufacturing industry, civil construction, etc.

In this study the modification of the low density polyethylene/aluminum from carton packages reinforced with cellulose fiber is investigated, and the addition of the grafted copolymer with maleic anhydride, acting as a compatibilizer, whose main target is to add value to the material produced, making them more attractive from a market point of view.

Grafted copolymer was added to the LDPE/Al composite and posteriorly extruded. Cellulosic fibers (wood), in different percentages and particle sizes, were mixed with the resulting material from the first extrusion, with posterior extrusion in sheets, with different resulting properties and aspects.

After processing, the obtained materials were applied to thermal and mechanical characterization, infrared spectroscopy and surface electronic microscopy to verify the efficiency of the modifications.

This research showed us that by increasing the cellulose fiber percentages in the generated composites increased mechanical properties and thermal stability in comparison to the original composite, and indicated a subtle action of the compatibilizer in the experimental conditions used.

GPEC 2007 Paper Abstract #RS11

Title: Thermoplastic Separation and Recovery for Various Mixed Scrap Plastics by the Argonne Developed Froth Flotation Technology

Authors: J.A. Pomykala, Jr., B.J. Jody, and E.J. Daniels, Argonne National Laboratory

ABSTRACT

Argonne National Laboratory has developed a froth flotation technology to separate various polymers from one another, including the separation of acrylo-nitrile-butadiene-styrene (ABS) from polystyrene. This technology, which separates overlapping density materials from one another in an aqueous solution, has been successful in the separation and recovery of polymers from various waste streams generated in the United States and the European Union. These streams have included shredder residue, white goods, small home appliance scrap, and electronics scrap. Presently Argonne is extending the process to separate and recover polymers from shredder residue which is a byproduct from the recovering of metals from end of life vehicles, home appliances and other metal containing materials. This work is sponsored by the U.S. Department of Energy and is done in cooperation with the Vehicle Recycling Partnership of the United States Council for Automotive Research (USCAR) and the American Plastics Council. This paper describes the Argonne processes as they were applied to a variety of mixed scrap plastic streams.

GPEC 2007 Paper Abstract #RS13

Title: Size Reduction for Effective Reclamation

Authors: John Farney, Cumberland Engineering & Keith Larson, Colortronic North America

ABSTRACT

Size reduction is an important part of any recycling or reprocessing operation. The physical properties of the materials involved require different systems to maximize the efficiency of your size reduction process. For example, bottles are ground up in one type of machine, while automotive bumpers require a slightly different system to generate the best quality regrind.

New developments in size reduction technology allow more flexibility, improved energy efficiency, ease of clean-out and improved regrind quality than ever before.

Starting your re-pelletizing process with a quality feed stream will produce a better quality product.

GPEC 2007 Paper Abstract #RS12

Title: Film Scrap Recycling/Reclaim Options

Author: Dana Darley, Extrusion Auxiliary Services, Inc

ABSTRACT

Film scrap can be very difficult to reprocess due to varying forms and contamination levels, as well as its light bulk density and poor feed characteristics, both before and after size reduction. We will take a look at all currently available technology for reprocessing film scrap, describe each process and review the Pros and Cons. We will then draw our conclusions and discuss proper application of each process. Technologies reviewed include: a) Simple edge trim re-pelletizing systems, b) Fluff/regrind direct reclaim systems for feeding ground scrap directly back to the extruder, c) Film scrap densification systems for producing agglomerated particles for easier blending and feeding, d) Traditional re-pelletizing systems where scrap is pre-size reduced, extruded and pelletized, and e) Combination re-pelletizing systems using specialty extruders, with integral shredder/compactors.

GPEC 2007 Paper Abstract #RS21

Title: Closed Loop Recycling of HDPE Milk Bottles From Post Consumer Waste Back to Food Contact Grade

Authors: Edward Kosior and Rob Dvorak, NEXTEK Ltd

ABSTRACT

The revolutionary technology represents the first time post consumer HDPE Milk bottles have been recycled back into Milk Bottles with full food contact status. The process is innovative in the unique separation technology and the decontamination process that it uses. The sorting process exploits a new sensitivity that can identify the homopolymer used in milk bottles apart from the balance of the HDPE bottles in the waste stream. The decontamination technology that has demonstrated it efficiency via challenge tests that it is capable of decontaminating HDPE to a "super-clean" state. The paper will describe the equipment and techniques used in the Food Contact HDPE recycling process and how the efficiency can be optimized by process design as well as describing the efficiency in removing a range of model and real life contaminants. The commercial aspects of the process will also be addressed as this is a key driver in the implementation of the technology.

GPEC 2007 Paper Abstract #RS15

Title: Processing of non-dried PET-Bottle-Scrap using Co-rotating Twin Screw Extruders

Authors: Paul Andersen, Coperion & Sabine Schönfeld,
Coperion Werner & Pfleiderer, Germany

ABSTRACT

PET consumption has been recording above-average growth rates for many years. The main reasons for this growth are the increasing popularity of PET for non-returnable and returnable bottles for beverages as well as the proliferation of various types of PET film packs, for example as deep-freeze packs suitable for oven or microwave use.

An increasing volume of reclaim material is accompanying this growth. Most of the scrap produced during processing – edge trim or punch scrap from the thermoforming of film packs, for example – is treated and recycled in-house, but large quantities of washed, sorted regrind material are also coming out of the consumer cycle.

PET being a polycondensate is hygroscopic and very quickly absorbs the equilibrium moisture of 1000-3300 ppm water (depending on the particular product). Therefore during plasticising non dried product, hydrolytic degradation will start immediately, as it is 10,000 times faster than thermal degradation caused by excessively high processing temperatures and 5,000 times faster than thermo-oxidative degradation caused by the presence of oxygen. Therefore the removal of retained moisture is the main problem for the processing and compounding of PET, even for virgin material. There are several possibilities for achieving low process moisture content:

- Standard-crystallization at 150°C and drying at 150–180°C
- Air-drying process at temperatures of up to 60 °C without crystallization
- Combination of pre-drying or conditioning and vacuum degassing
- **Vacuum degassing during extrusion**

This presentation will review the Co-rotating twin-screw extrusion technology which eliminates not only the pre-drying of the recycled or virgin material but also the crystallizing and agglomerating process. With over 65 lines in operation, the technology has been shown to be suitable for virgin material, for all kinds of regrind and recyclate, and for blends of these materials. In addition to pellets it can directly produce sheet, film and fiber.

GPEC 2007 Paper Abstract #RS16

Title: Polymer Filtration Options for Plastics Recycling

Author: Dan Smith, PSI

ABSTRACT

Precise polymer filtration is required to produce the best resin from the reclaim process. Selection of the correct filtration equipment can often determine the quality and the price per pound ultimately received from the finished product. Additionally, correct filtration specification can impact the amount of product produced due to downtime and other service issues. Most major types of filtration will be discussed along with the advantages and disadvantages of each type. Selection criteria will be presented to assist processors in determining which type would be best for their specific process requirements.

GPEC 2007 Paper Abstract #RS17

Title: Post Consumer Resins and the Road Ahead

Author: Michael Schedler, NAPCOR

ABSTRACT

No abstract currently available.

GPEC 2007 Paper Abstract #RS14

Title: Material Handling Considerations for Reclaim Extrusion

Author: Keith Larson, Colortronic North America

ABSTRACT

Material handling is an integral part of an efficient reclaim processing operation. The reclaim material and other ingredients need to be conveyed and blended in the correct proportions to ensure a quality product out of the downstream end of your process.

Conveying systems work better if they are designed for the specific material to be handled. For instance, film reclaim is a much lower bulk density, so it is conveyed differently than traditional pelletized resins. Powder additives, and resins, are much heavier, and present a different set of design parameters.

Blending and feeding can be as simple as a volumetric auger, and as complex as a complete loss-in-weight feeding system. One is more expensive than the other, but offers many advantages over the traditional volumetric systems.

It is important that the material handling part of your system is properly designed, or you will not maximize the performance of your extrusion process.

GPEC 2007 Paper Abstract #RS18

Title: FDA Approved Pet Polymers Containing PCR Recycled Content

Author: Jeffery Best, Invista

ABSTRACT

No abstract currently available

GPEC 2007 Paper Abstract #RS19

Title: The Most Environmentally Friendly Barrier Enhancement for PET Bottles

Author: Peter K. Andrich, SIG Beverages North America Inc

ABSTRACT

No abstract currently available

GPEC 2007 Paper Abstract #RS20

Title: **Celstran Recycling Concept-Incorporation of LFT Production Scrap Into Celstran Pultrudate**

Author: Gabi Thomas, Heinz Bernd, Ticona

ABSTRACT

The EU's End-of-Life Vehicle (ELV) Directive 2000/53/EC not only specifies recycling and recovery quotas applicable from 2006 but also requires prevention of waste. To achieve this goal, production scrap should – if possible- be recycled back into the production process in a systematic and reliable way. Start-up and punch scrap can generally be returned to the production process in suitable ratios after size reduction, provided that application requirements permit. This can lead to variations in processing behavior and the material property profile. Working in consultation with VW, Ticona has succeeded in incorporation long-fiber-reinforced thermoplastic production scrap in to long-glass-fiber pellets used to mold the dashboard support for the Golf A5 and the Golf Plus. This means that after suitable processing by a qualified recycling company, Ticona takes back the punching scrap and incorporates it in virgin material. The resulting product is then processed into dashboards.

GPEC 2007 Paper Abstract #RA1

Title: Moving Toward Sustainable Plastics 2006/7 Report Card of Leading Automakers

Authors: Jeff Gearhart, Charles Griffith, Claudette Juska – Ecology Center

ABSTRACT

Plastics use in automobiles is large and growing. Today, nearly 50% of vehicle interior components are made of polymers. In many cases these plastics have chemical additives that are toxic and off-gas to contaminate the air and dust inside vehicles. Also of concern, these materials are added to the waste stream and incinerated or landfilled at the end of vehicle life, causing contamination of land and air. With vehicle sales and plastics usage both on the rise, the use of sustainable plastics that are healthy and safe for vehicle occupants, and provide reusable feed stocks at the end of their useful life is of increasing importance. In this report we have provided a comprehensive review of automaker activities relating to sustainable plastics. We have found that there is a heightened effort within the auto industry to use bio-based materials in vehicles. We have also found that some manufacturers have made significant strides in phasing out problematic plastics, such as PVC, and switching to more recyclable materials that have fewer toxic chemical additives. While there is progress in the industry, some automakers are falling far short of their competitors. And, even the leading automakers can still do more to increase the sustainability of materials in their vehicles

GPEC 2007 Paper Abstract #RA2

Title: RA2. A Study on Recycling Plastic Materials in Heavy Trucks

Authors: Srikant Ghantae & Noelie Paperella, Volvo 3P

ABSTRACT

Heavy Vehicles are essential to today's society for hauling a variety of goods from place to place. The demand for these vehicles is continually increasing. However, to produce such vehicles and during the manufacturing phase there is a large amount of waste generated. A number of different materials are also used to build the vehicles that are thrown away at the end of the product's life cycle.

About 75 percent of an end-of-life vehicle (mainly metals) is recyclable in the Europe and in the United-States. The rest (~25%) of the vehicle is considered waste and generally goes to landfills. Environmental legislation of the European Union requires the reduction of this waste to a maximum of 5 percent by 2015. In the recent times the use of plastics on the Heavy vehicles has increased substantially. Studies have been done in the automotive industries to recycle the material from the plastics, unlike metals are harder to recycle, as it involves more preparation for breaking down. Another issue is that, plastics are often made up of more than one kind of polymer, surface treatments are hard to remove and isolate or there may be some sort of reinforcements or additives to modify the mechanical properties. Most commonly used plastic materials were SMC (Sheet Molding Compound), DCPD (DiCycloPentaDine), and PC Blends of ABS, PBT with and without fillers.

The objective of this study is to find out the existing situation life cycle of heavy trucks from cradle to grave and recommend future actions that need to be taken in order to minimize the waste and increase the recyclability of the product.

GPEC 2007 Paper Abstract RA3

Title: RA3. Alternatives to Chrome Plating and Related Chemical Use in Creating Automobile, Light Truck, and Heavy Truck Decorative Components

Author: Gordon C. Miller, M.,M.,&A., LLC

ABSTRACT

Recently, the U.S. Department of Labor's Occupational Safety and Health Administration created a final rule for hexavalent chromium determining that hexavalent chromium is a carcinogenic material and reducing the permissible exposure limit (PEL) to 0.5 µg/M^3. By this action, the workplace standard for this chemical was reduced from 100 µg/M3 as a ceiling concentration measured as chromic acid (CrO_3) to approximately 1/200th of the previous standard. This presents a significant challenge to chrome plating operations and those who use chrome plated products.

Similarly, other hazardous chemicals are used in related plating of these same parts that have toxicity and handling issues that create additional workplace and environmental management issues. In the European Union (EU), the list of "heavy metals" that is part of EU Directive 2002/95/EC (Restriction of the use of Hazardous Substance in Electrical and Electronic Equipment) creates issues for future management of waste electronic materials and likely forecasts potential additional regulation for materials used automobile, light truck, and heavy truck systems.

This paper will review, from an environmental health and safety perspective, both traditional chrome plating and alternatives to chrome plating in automotive, light truck, and heavy truck situations. The primary focus will be on exterior and interior finish and trim products.

Where positive effects and impacts on workplace and environmental quality are found, they will be identified and presented in the light of the needs of the automotive industry to meet customers demands for a well designed and attractive product along with meeting the needs of the after-market industry including body repair.

GPEC 2007 Paper Abstract #RA4

Title: 100% Environmentally Friendly Surface Treatment Process

Author: Simon Brynolf, FTS Technologies

ABSTRACT

The evolution of current Surface Treatment processes has not kept pace with the development of modern day material substrates and product designs currently in use in today's global plastics and metals finishing industry. The demands for superior product quality, reduced costs, and higher manufacturing volumes have surpassed the capabilities of current surface treatment technologies. Recognizing this stagnation, FTS Technologies and its partners have developed the revolutionary ATmaP (Accelerated Thermo-molecular adhesion Process). ATmaP is a fast, efficient, and 100% environmentally friendly surface treatment process that completely eliminate the need for adhesion promoting primers, and alike, in all painting, bonding, laminating, printing, and decorating applications.

FTS Technologies has been recognized within the automotive industry with an Environmental Leadership Award, as well as a Clean Air Excellence Award. We are also members of the Suppliers Partnership for The Environment, which is affiliated with the EPA as well as OEM's such as Daimler Chrysler and General Motors.

GPEC 2007 Paper Abstract #RA5

Title: Mixing PC/ABS Regrind: A Preliminary Study

Authors: Ewa Lebert & Susan Kozora, Visteon Corporation

ABSTRACT

The use of different grades of the same type of resin is not uncommon in automotive manufacturing facilities. As a consequence, the use of internal regrind becomes cumbersome due to increased material handling, storage and cross contamination possibility between the different grades of the same resin. The ability to combine the regrind streams would alleviate these consequences as well as promote the usage of the recycled resin within a given manufacturing facility versus recycling via outside sales or even landfill which is typical with mixed recyclate streams. In this study, recyclate of two different grades of acrylonitrile-butadiene-stryrene and polycarbonate blend (PC/ABS) resins from different suppliers were evaluated. Various ratios of the two grades were evaluated where the blending occurred in both regrind and reprocessed/repelletized forms. Due to the nature of this study, certain preliminary properties were evaluated prior moving forward with other plaque and/or part testing. The properties evaluated were melt flow, flexural modulus and izod impact strength at room temperature. The melt flow and flexural modulus values were evaluated for each ratio and revealed a linear relationship. The izod impact strength was evaluated at 50/50 blends of the two different grades initially, along with the corresponding controls, to detect possible incompatibility issues since the resin manufacturing process of the two prime PC/ABS resins differ. Since there were no drastic changes in the impact strength, further testing of the other ratios was not pursued. As expected, the mixing of the two different grades of PC/ABS recyclate for reuse back into the same or similar automotive components appears feasible and warrants further testing in situations where various grades of the same resins are used within a given manufacturing facility to promote internal recycling.

GPEC 2007 Paper Abstract #RA6

Title: **Converting Post Consumer Recycle PET Waste into PBT Based Engineering Thermoplastics for Automotive and Electrical Applications**

Author: Dhaval Shah, GE Plastics

ABSTRACT

4 billions pounds of PET bottle waste is generated in the US every year. Only 20 % of this material is recovered for recycling purposes. The rest of it is dumped into landfills across the country. GE has developed products (Valox iQ* and Xenoy iQ* resins) that are made from a PBT copolymer that is made by chemical regeneration of PET into the PBT copolymer which is used as a base resin to make molding compositions. These products can then be used in a variety of automotive and consumer applications. These innovative products' manufacturing processes require less energy and non-renewable fossil fuels as compared to the manufacturing processes of conventional fossil fuel based materials. Also, a substantial amount of CO2 emissions reduction can be achieved (in a cradle to grave type analysis) by practicing this technology. This paper will give insights into the proprietary Valox iQ* and Xenoy iQ* technology as well as the eco-impact of this technology.

* Trademarks of General Electric Company

GPEC 2007 Paper Abstract #RG1

Title: Anhydride Functional Ethylene Copolymers as Compatibilizers for Polyethylene Rich Mixed Recycle Streams

Authors: Gregg B. Babcock and David M. Dean, DuPont

ABSTRACT

Over the past several years, the ability of maleic anhydride grafted polymers to compatibilize polar contaminants with a polyolefin matrix has been confirmed by a number of groups working in this field. These maleic anhydride grafted polymers, typically containing 0.5 to 1.5 weight percent maleic anhydride, improve physical properties of the mixed recycle streams by acting as a compatibilizing agent that binds polar contaminants such as EVOH or nylon to the polymer matrix. This compatibilization is driven by a chemical reaction of the maleic anhydride functional group with co-reactive groups attached to the contaminants such as hydroxyl groups associated with EVOH or amine groups associated with nylon.

In this study, we report on next generation additives based on high molecular weight, random copolymers of ethylene and anhydride functional monomers that have been specifically designed for compatibilizing a polyethylene phase with non-polar components in mixed recycle streams.

By using a standard high-pressure free radical synthesis technique, DuPont has created a high molecular weight ethylene copolymer with a very high level of reactive functionality (greater than 3 weight percent anhydride). This anhydride-functional-ethylene copolymer has been shown to improve the impact strength of molded or extruded parts made from mixed recycle streams containing EVOH even when the scrap source additionally contains high levels of moisture, lubricant, or nylon. The property improvements provided by the ethylene copolymer additive can be obtained when using the compatibilizing agent at loading levels as low as 0.5 weight percent in the final part. This compares favorably to the higher loadings of traditional anhydride-grafted polymers that are needed to achieve the same performance.

This new generation of functional ethylene copolymer additive will allow the industry to provide products with improved performance at reduced cost.

Data will be presented comparing the compatibilizing performance of traditional maleic anhydride grafted polymers with the new generation of ethylene copolymers containing enhanced anhydride functionality.

GPEC 2007 Paper Abstract #RG2

Title: Chemical recycling of PET wastes in powder form

Authors: Behzad Shirkavand Hadavand, Iran Polymer and Petrochemical Institute &
Hossein Hosseini, Abadan Azad University

ABSTRACT

A novel process called solid state shear pulverization has been developed to convert PET wastes into controlled particle size powder and then alkali degradation of PET powders taken from post-consumer soft-drink bottles was revealed to be an efficient method for the reproduction of pure terephthalic acid and ethylene glycol. The reaction took place in a reactor at pressure 10-20 bar with aqueous alkali solution. The salt of terephthalate received was treated with acid and terephthalic acid of high purity was separated. This method is very useful in recycling of PET bottles and other containers because nowadays TPA is replacing dimethyl terephthalate (the traditional monomer) as the main monomer in the industrial production of PET.

GPEC 2007 Paper Abstract #RG4

Title: Microcellular Recycled PET Foams for Food Packaging

Authors: Dr. Vipin Kumar & Krishna V. Nadella, Dept of Mechanical Eng,
University of Washington & Greg L. Branch, MicroGREEN Polymers, Inc.

ABSTRACT

Microcellular polymers refer to thermoplastic foams with a large number of very small bubbles of order 10 μm in diameter. In this paper we present a study of recycled PET – CO_2 system for sub-critical processing. It was found that the recycled PET can be foamed using CO_2 and a uniform microcellular structure is produced.

Recycled PET crystallizes when exposed to high pressure CO_2. This phenomenon is employed to create foams with varying levels of crystallinity, thus enabling varying levels of service temperatures. A novel thermoforming process to convert sheets of microcellular RPET into food packaging products such as cups and trays was developed. Deep drawn cups of about 1mm wall thickness were produced with a smooth surface finish. The cups are heat-stable to 350 F, and can be recycled after use.

This technology is expected to generate many new applications for recycled PET.

GPEC 2007 Paper Abstract #RG3 Part 1 & 2

Title: PVC Recovery and Recycling in Europe -Part 1 &2

Author: Sascha Schuh, ASCON GmbH

ABSTRACT

PVC a Plastic with a wide variety of usage

- Advantages
- Disadvantages
- Main Problems

- **PVC in the waste streams**
  - Total amount
  - Flexible PVC
  - Rigid PVC
  - Different waste streams

- **Collection of PVC waste**
  - Industrial waste
  - Commercial waste
  - Household waste

- **Technology for PVC separation**
  - NIR
  - X-Ray
  - Electro static
  - Swim sorting
  - Manual sorting

- **Technology of recycling**
  - Material recycling
    - *Mixed PVC*
      - DOW
      - SVZ
      - Brown coal energy plants
    - *Flexible PVC*
      - Kryogene Technology
      - Extrudation Kalandation to re-usage Plastics
    - *Hard PVC*
      - Direct re-usage in the origin of the material
      - Re-usage in a mixed colour fraction (Kabelkanäle)
  - Raw material Recycling
    - *Re-usage of Oil and Chloride*
    - Newest technologies
      - SKW Troisberg
      - CVP Buxdehude
      - Vinyloop
      - Solvay

- Recovinyl – post consumer System for PVC Recovery and Recycling in Europe

GPEC 2007 Paper Abstract #RG8

Title: How to Structure, Finance, And Fund Your Clean Technology Venture: Start-Ups, Corporate Governance, Venture Capital, Strategic Alliances, & Private Equity in a 'Green' Marketplace

Author: Eric Koester, Esq., Heller Ehrman LLP

ABSTRACT

With literally millions of new capital in venture funds, private equity funds, and hedge funds now focused on clean technology, the opportunities for innovation in the clean tech arena are substantial. That's right, investing to better the environment is hot again. But what is the 'right' way to start your clean technology venture? How can you take advantage of the marketplace and properly position your business or idea? What are the pitfalls to avoid and the opportunities to grab onto? This interactive session will help a new inventor, an individual with a new idea, or the curious innovator learn about the prospects in the marketplace -- how to fund a new venture and structure it for long-term successes. We'll address questions like the best forms of the organization, intellectual property protections, stock options, where to locate your venture, off shoring, the financing options available, and much more. By better understanding how to structure and manage the early development of your clean technology venture, you can position yourself for this unique market. Eric is an attorney specializing in start-ups and emerging companies in the areas of software, life sciences, and clean technologies.

GPEC 2007 Paper Abstract #RG5

Title: Compatibilizers for Recycle Products

Author: Bill Sigworth, Chemtura Corporation

ABSTRACT

Abstract - Several types of functionalized polymers will be described which are effective compatibilizers for the blends of dissimilar polymers often encountered in recycle streams. The paper will show how these compatibilizers improve the properties of engineering plastic blends with polyolefins and of environmental friendly composites like wood waste and recycled polyolefin resins.

GPEC 2007 Paper Abstract #RG7

Title: Resource Productivity and Sustainable Growth: Applying nature's principles to extend a material's DNA to its next life

Author: Dr. Seetha Coleman-Kammula, NextLife LLC

ABSTRACT

In the field of sustainable development one of the challenging issues is the rate at which materials and energy are converted into waste. Consider the following statistics: (Ayres, 1998)

- For every 100 pounds of product manufactured, we create about 3,200 pounds of waste; and,
- Only 6% of the materials we extract each year from the Earth become durable goods; the other 94% is converted into waste within a few weeks or months.

While the above figures apply to all materials from the time they are extracted from the earth to the time they are discarded, our analysis of articles made from major thermoplastics confirms indeed that about 87% of commodity thermoplastic are discarded within a few weeks to months of production from crude oil. At today's prices this amounts to sending $15 to 20 billion (enough to eradicate Malaria) to landfill sites around the country at a high cost to society. While the tremendous benefits that plastics have provided to society are undisputable, this level of wasted wealth, combined with their impact on Greenhouse gases and carbon footprint during their lifetime call for a concerted effort to find balanced solutions

This paper present a strategic framework for sustainable business growth based on a model of sustainable production, recovery and re-use. As a starting point, there are two sets of guiding principles, called Ecological Principles and Economic Principles. They apply nature's principles to guide the use of a single material along a time line to preserve and extend the material's DNA to its **next life.** By designing and making simple short lived articles first, and subsequently using the nearly pure material again for complex long lived articles the **time-value of materials** can be extended. By proactively facilitating the transfer of materials and information from one manufacturer to the next at the end of the useful life of the articles manufacturers could benefit financially. Application of these principles reduces the amount of material and energy input and recaptures some of the value lost to waste and enhance both ecological and economic value.

However to capture significant value from these principles companies must look beyond their own boundaries and even beyond their traditional value chain to non-traditional partners who can give their materials a next life. Realizing these opportunities requires a shift in thinking to conceive new business models and non-traditional relationships. This paper will explore a few business frameworks for re-thinking the business model, re-designing the products and re-engaging employees.

GPEC 2007 Paper Abstract #RG6

Title: Characterization of Post-Consumer Plastic mixtures Compatibilized by Block Copolymers

Authors: Sarah Bobek, Aniket Selarka, Ned V. Gvozdic and Charles L. Beatty, University of Florida

ABSTRACT

Mechanical properties of mixed post-consumer plastics were improved by addition of block copolymers. When block copolymer of appropriate molecular architecture is added to mixed plastics, it can serve as compatibilizer improving the interfacial strength between different plastics. Mechanical properties of these polymer systems have been maximized by addition of combination of block copolymers. Properties of these polymer systems were even further enhanced by the addition of natural fibers.

Properties of compatibilized and fiber reinforced mixed post-consumer plastics were compared against the non-compatibilized and non-fiber reinforced mixed plastics having the corresponding compositions. Phase morphology was characterized by examining the fracture-surfaces imaged by Electron Scanning Microscope. Mechanical properties were characterized by measuring tensile and impact properties.

GPEC 2007 Paper Abstract #RE1

Title: MSS e-Sort™ Automated Optical Sorting of Electronic Scrap

Author: Felix A. Hottenstein, MSS, Inc. Nashville, TN

ABSTRACT

This paper presents the latest optical separation technologies for automated sorting of electronic and electrical scrap. The MSS e-Sort™ is an 'all-in-one' optical sorting module providing identification and separation of the following materials:

1) Plastics: ABS, HIPS, PC, blends
2) Circuit Boards
3) Metals: Ferrous, non-ferrous, stainless

The e-Sort™ combines state-of-the-art near-infrared spectroscopy with induction metal detection technology. It is can also be upgraded with color-sorting capabilities if required. One machine can generate either two outputs from one input stream (one positively ejected fraction, one pass fraction) or three outputs (two positively ejected fractions, one pass fraction).

Advanced statistics allow the operator to track material composition, throughput by the hour, day or truckload. Quality control reports can be generated that are compatible with ISO 9000/14000 standards.

GPEC 2007 Paper Abstract #RE2

Title: Utilizing Due Diligence to Minimize RoHS Risks

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

ABSTRACT

OEMs and suppliers need to comply with numerous global and regional environmental regulations. In particular, the European Union's Restriction on Hazardous Substances (RoHS) Directive, which became effective on July 1, 2006, mandates that companies provide compliant product in EU member countries. This supply chain challenge is also being extended to other regions of the world as China, Japan and many other countries and states announce sweeping environmental regulations. Companies must be able to demonstrate that they took all reasonable steps and exercised all due diligence to avoid committing an offense. This presentation will discuss various compliance strategies, including the use of material declarations, supplier qualification programs, material risk assessments and the use of analytical and screening tests.

GPEC 2007 Paper Abstract #RE3

Title: RoHS and WEEE and How it Has Affected Our Designs for Process Controls for the Plastics Industry

Author: Thomas Linehan, D-M-E Company

ABSTRACT

My intent is to cover RoHS and WEEE and how it has affected our designs for process controls for the plastics Industry. This is no longer a European thing; California goes on line January 2007. China is expected to follow suit, as is Japan.

We changed all of our designs from through-hole to surface mount and changed all of the components to lead free. The material for the circuit boards had to change, as well. Some of our electrical enclosures used to be plated with Hexavalent Chromium. These were all changed over to Trivalent Chromium. We also purchase and resell a number of pieces of electrical based polishing equipment and welding equipment. We had to have the suppliers of these change their designs over to conform to RoHS and WEEE.

There are lingering concerns, tin whiskers being one of them. Higher processing temperatures are required for the new solder that is used and that can create some issues with components and circuit boards. Some are concerned that the longevity of the assemblies will be affected by the new processes that are being used.

There is some confusion in the RoHS standard, as well. Process control equipment is supposedly excluded. However, temperature control apparatus are excluded from the exclusion. We sell a lot of temperature controls for use with Hot Runner systems. There is also some expectation that the exclusions will go away over time. Therefore it is best to prepare for compliance with RoHS now.

WEEE now requires that the manufacturer or distributor take back electrical components at end of life and recycle them. Some of what was expected to be in place in August of 2005 is in fact not in place. Europe was expected to create clearing houses where manufacturers could list the types of equipment that they sell into that region. The last I looked, these were not in place yet.

GPEC 2007 Paper Abstract #RE4

Title: Recycling ABS from End-of-Life Electronics into Wood-Plastic Composites

Authors: Shu-Kai Yeh, Sushant Agarwal & Rakesh K. Gupta, Dept. of Chem. Engineering
West Virginia University

ABSTRACT

Efforts aimed at recycling post-consumer plastics into high-value applications involve separating polymers by chemical type since the collection process necessarily results in commingled plastics, and mixed plastics have poor mechanical properties. In our prior work, we have suggested that a more viable strategy is to add fillers or reinforcements to mixed plastics in the expectation that these fillers would mask and even overpower the composition-dependent variation of mechanical properties of the base polymer. We demonstrated the truth of this hypothesis by adding 15 wt% short glass fibers to polycarbonate obtained from end-of-life electronics; the mechanical and flow properties of the reinforced polymer containing as much as 25% impurities were found to be indistinguishable from the corresponding properties of the glass-reinforced polymer formulated with 100% virgin polycarbonate. In the present work, we show that it is possible to extrusion compound superior quality wood-plastic composites from ABS recovered from computer monitors and keyboards by the addition of 50 wt% wood particulates and appropriate additives. These composites are more commonly prepared from reused polyethylene, typically derived from grocery bags, and the major applications include decking, fencing, roofing and wall siding for the housing construction industry. Here, we present mechanical property data to show that recycled ABS ought to be the polymer of choice for the commercial production of wood-plastic composites.

GPEC 2007 Paper Abstract #RE5

Title: Material Recycling of a Mixture of Residual Plastics from Waste Household Appliances

Author: Yuichi Matsuo, Mitsubishi Electric Co. Ltd.

ABSTRACT

In Japan, the 'Law for Recycling of Specified Kinds of Household Appliances' took effect in 2001. The manufacturers were responsible for 50-60wt% recycling of the disposed household appliances. In expectation of 80-90wt% recycling rate requirement in the future, development of material recycling technologies for plastics is needed to achieve 80wt% recycling. The material recycling simultaneously leads to reduce environmental load and cost. In generally, the treating processes of recycled plastic consist of a mixing, washing and pelletizing process. However, there are few studies regarding the mechanical properties and reliability of the recycled polypropylene sorted from a mixture of residual plastics of wasted household appliances. In this paper, the mechanical properties and reliability of the recycled polypropylene of waste household appliances collected in a recycling plant, Hyper Cycle Systems (Chiba, Japan) were estimated. Historically, a mixture of residual plastic of waste household appliances has been discarded in landfill or used as blast furnace fuels.

The polypropylene of more than 99.8% of purity was taken out of a mixture of residual plastics by gravity sorting technology and contamination removal technology. The recycled polypropylene was stabilized by inorganic additives to reduce deleterious effects of contamination and secured the long-term stability in the polypropylene. The all technologies have potential to realize 30% reusability of a mixture of residual plastics of waste household appliance into high grade polypropylene. The recycled polypropylene was applied to the interior part of washing machine.

GPEC 2007 Paper Abstract #RR1

Title: Flame Retardants: Fire Safety, Regulatory Status & Current Issues

Authors: Raymond B. Dawson & Susan D. Landry, Albemarle Corporation

ABSTRACT

The invention and proliferation of plastics has helped to make our society a better place to live. Flame retardants improve the fire safety of plastic used in many everyday products. Since flame retardants work in a passive mode to help prevent fires from starting and slow down the progress of fires that do start, we generally do not realize the important role they have in helping to protect our safety and well being. 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 have received a considerable amount of negative publicity due to perceived environmental and toxicological issues. 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, have completed or 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 (including the status of REACH) involving various flame retardants will be presented.

GPEC 2007 Paper Abstract #RR2

Title: Greenguard Certification-Goods with Low Chemical & Particle Emissions for Indoor Use

Authors: Bob Young, Eastman Chemical

ABSTRACT

Indoor Air Quality is becoming more of a major concern to building owners, designers and occupants. This presentation will discuss the Greenguard Environmental Institute, Indoor Air Quality and the Greenguard Certification process. The Greenguard Environmental Institute oversees a testing and certification program for low-emitting products and materials used in interior spaces and buildings. Representative samples of products and materials are evaluated for chemical emissions to determine their impact on Indoor Air Quality. Many product specifiers and construction contracts call for materials that have Greenguard Certification.

GPEC 2007 Paper Abstract #RR3

Title: New Developments in Plastics Identification Technology Open New Ways In Plastics Recycling

Author: Peter Mayer, S+S Separation and Sorting Technology GmbH

ABSTRACT

New legislation on WEEE scraps in Europe and worldwide requires a relatively high degree of sorting post consumer electronic devices and separating them in a number of different material categories to recycle the single material streams. This paper will present a summary of the most significant advancements in separation and sorting technology to achieve maximum economic product yield.

In the past there have not been adequate technologies available to separate electronic scrap into their constituents thus only the possibility for high cost dismantling by hand or land filling the waste. New sorting technologies based on high speed computer systems and intelligent multi-sensor-systems enables us meanwhile to separate metals from plastics, to separate plastics by plastics type and even separate Brominated flame-retardant plastics from plastics without flame-retardants. The paper will give an overview of typical sorting applications within the recycling loop for electronics waste.

These new technologies enable the recyclers to economically recover valuable materials.
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GPEC 2007 Student Poster Abstract #1

Title: Development of Biodegradable Polylactide / Nanoporous Zeolite Composites

Authors: Isinay E. Yuzay, Rafael Auras, Susan Selke *School of Packaging, Michigan State University

ABSTRACT

An increased awareness of environmental issues is driving the need to use biodegradable polymers. Polylactide (PLA) is one the most widely-used biodegradable polymers derived from renewable resources. In this study, the preparation and characterization of polylactide (PLA) composites containing nanoporous zeolites (Type 4A) have been studied. Zeolites are crystalline alumino-silicates, consisting of SiO4 and AlO4 tetrahedras. Due to their chemical inertness and unique pore structures, zeolites can be used as a molecular sieve and can be a promising candidate for the fabrication of functional polymer composites. Polylactide (96 % L-Lactide) containing 0, 1, 3, and 5 wt % zeolites were prepared using a micro-compounding machine having a co-rotating twin screw extruding unit with an injection molder. Morphological, thermal, and mechanical properties of PLA/nanoporous zeolite composites were investigated.

GPEC 2007 Student Poster Abstract #2

Title: Rheological & Degradation Properties of Renewable Resource Polymer Blends based upon Poly-hydroxyalkanoates and Poly-lactide

Authors: Jason D. Conrad, James P. Eickhoff, and Graham M. Harrison, Department of Chemical & Biomolecular Engineering and Center for Advanced Engineering Fibers & Films Clemson University

ABSTRACT

There has been a significant amount of research over the last decade focused on developing renewable resource polymers for commodity applications. Bio-derived polymers, such as poly-hydroxyalkanoates (PHA) and poly-lactide (PLA), have been shown as suitable alternatives to some conventional fossil fuel-based polymers. They can have similar mechanical properties, yet they come from renewable resources, and they can degrade under the appropriate conditions. These latter attributes can make them better for our environment. In this work, we examine the shear and extensional rheology of two PHA copolymers based upon 3-hydroxybutyrate, PLA, and blends of the PHA and PLA materials. Degradation at typical processing conditions was also studied using transient rheological testing along with GPC measurements to examine how different testing parameters affected molecular weight as a function of time. The goal of these studies is to determine viable conditions, methods and blend compositions by which these materials could be processed for commercial applications.

GPEC 2007 Student Poster Abstract #3

Title: Mechanical Behavior of Polyethylene Terephthalate Fibers Processed with Vapor Grown Carbon Nanofibers (VGCNFs)

Authors: Rodney D. Averett and Mary L. Realff, Ph.D., School of Polymer, Textile, and Fiber Engineering, Georgia Institute of Technology

ABSTRACT

PET control fibers (diameter ~24±3 μm) and heat treated polyethylene terephthalate (PET) fibers with embedded vapor grown carbon nanofibers (VGCNFs) (diameter of ~25±2 μm) were exposed to monotonic tensile tests and cyclic loading. The control fibers were processed through a typical melt-blending technique and the PET/VGCNF samples were processed with approximately 5 wt.% carbon nanofibers present in the sample. When tested at a strain rate of 6.69E-03 s^{-1}, the mechanical properties of the PET/VGCNF samples outperformed the control samples; elastic modulus, hardening modulus, yield strength, yield strain, fracture strength, and tensile energy of the PET/VGCNF samples were all higher than the control samples. The constitutive response of both the pristine PET control samples and PET/VGCNF samples was modeled as a Ramberg-Osgood solid [1] with significant strain hardening.

When cycled above the static yield point for a few cycles, the PET/VGCNF samples absorbed ~79% more energy in the form of hysteresis.

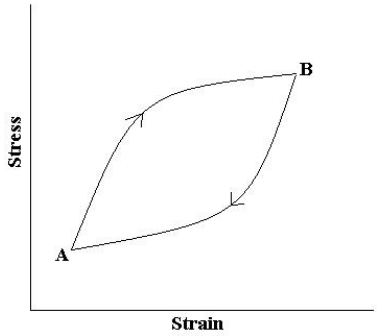

Figure 1. Representation of the hysteresis phenomenon

From Figure 1, the equation that appropriately describes the energy dissipated during one load-unload cycle (1.1) is:

$$E = \oint \sigma \, d\varepsilon = \int_A^B \sigma \, d\varepsilon - \int_B^A \sigma \, d\varepsilon \qquad (1.1)$$

More appropriately, the integration from the standpoint of energy absorbed during one cycle in terms of angular frequency is [2]:

$$E = \int_0^{2\pi/\omega} \sigma \frac{d\varepsilon}{dt} dt \qquad (1.2)$$

Under uniaxial fatigue conditions for a large number of cycles, the fibers were subjected to a maximum stress that was approximately 80% of the yield stress of the sample at a strain rate of 6.69x10^{-3} s^{-1} in uniaxial tension. The equation that appositely describes this dynamic loading condition is:

$$\begin{aligned} \varepsilon &= (\quad)\sin \omega t \\ \sigma &= (\quad)\sin(\omega t + \delta) \end{aligned} \qquad (1.3)$$

GPEC 2007 Student Poster Abstract #3 (cont'd)

In 1.3, $?$ is the instantaneous strain, $?_a$ is the strain amplitude, $?$ is the angular frequency, $?$ is the instantaneous stress, $?_a$ is the stress amplitude, and $?$ is the phase lag component of the strain. For same stress dynamic loading conditions under fully reversed loading, the phase lag component of the PET/VGCNF samples was higher than the PET control samples. The average value of the time lag differential for the PET/VGCNF samples was 0.018s, whereas the average time lag differential for the PET control samples was 0.014s.

Subsequent to non-destructive fatigue conditions, the fibers were tested under uniaxial stress conditions. The fracture strength and tensile energy of the samples in uniaxial tension subsequent to fatigue were shown to be dependent on the cyclic stress amplitude (? ?) and prior accumulated strain for a fixed frequency of 5Hz. For the PET/VGCNF samples, there were negligible effects on the static yield point and modulus subsequent to fatigue. The effects of the fatigue process on these mechanical properties have been hypothesized and supported through existing qualitative and quantitative analyses.

References

1. Ramberg W and Osgood WR. Description of stress-strain curves by three parameters. Technical Notes: National Advisory Committee for Aeronautics. No. 902. Washington, July 1943.

2. Ward IM and Hadley DW. An Introduction to the Mechanical Properties of Solid Polymers. John Wiley & Sons Ltd., West Sussex, England. October 2000.

GPEC 2007 Student Poster Abstract #4

Title: Advantage of Material-recycle for Polypropylene with Nanofibers

Authors: Miwa Tenma and Masayuki Yamaguchi,
Japan Advanced Institute of Science and Technology

ABSTRACT

The effect of processing condition of polypropylene with nanofibers composed of sorbitol-derivatives on the optical properties has been studied considering the material-recycle of injection-molded products. It is known that sorbitol-derivatives form fibrous structure with a diameter of about 10 nm in a molten polypropylene. These fibers orient to the flow direction at injection-molding, leading to high level of molecular orientation.

This study proves that transparent products are obtained at lower resin temperature at reprocessing when the virgin products show high level of molecular orientation. The experimental results suggest that the injection-molded polypropylene with nanofibers is appropriate for recycling by the following reasons; (1) shorten the cycle time at injection-molding, (2) avoid discoloration due to the decomposition of sorbitol-derivatives and/or polypropylene, and (3) reduce the energy consumption.

GPEC 2007 Student Poster Abstract #5

Title: Enhancement of Melt Elasticity by Addition of Critical Gel for Biomass-based Plastics

Authors: Keiichi Arakawa and Masayuki Yamaguchi,
Japan Advanced Institute of Science and Technology

ABSTRACT

The new technology to enhance the melt elasticity, which is one of the most serious problems for biomass-based plastics, is proposed in this study. It is found that the small addition of the critical gel with less crosslink points, whose network chains are miscible with the biomass-based polymer, improves the melt tension to a great degree, although it has little effect on the shear viscosity. Furthermore, Barus effect due to the normal stress difference, a typical elastic property of a polymer melt, becomes prominent with increasing the content of the critical gel. As a result, various processes, such as extrusion, blow-molding, thermoforming, and extrusion foaming, are applicable for biomass-based plastics.

GPEC 2007 Abstract #6

Title: Effects of Injection-Molding on Polylactide Properties

Author: Richard Haibach, Plastics Engineering Department
Penn State University at Erie, The Behrend College

Abstract

The effects of injection-molding on the mechanical and aesthetic properties of biodegradable polylactide (PLA) parts were studied. Standard tensile test specimens were molded from NatureWorks® 3051D injection-molding grade PLA. Barrel residence time, machine nozzle temperature, and shear rate were varied during the injection-molding process. The resulting specimens were analyzed in a tensile testing machine. Tensile strength, tensile modulus and visual inspection were used to characterize the extent of degradation that occurred during each process.

GPEC 2007 Abstract #7

Title: Packaging Sustainability: Life Cycle Assessment of PLA, PET & PS

Authors: Santosh Madival[1], Rafael Auras[1]*, Sher Paul Singh[1], Ramani Narayan[2]
1. School of Packaging, Packaging Building, Michigan State University
2. Department of Chemical Engineering, Michigan State University

Abstract

Sustainable development in the field of packaging is globally receiving attention. Sustainable packaging is defined as a cradle to cradle flow of packaging materials in a packaging system which provides economic, social and environmental benefits throughout its life cycle. With the advent of commercially available biodegradable polymers such as NatureWorks PLA®, Nodax®, Eastar Bio, and Biomax®, the packaging industry has been able to find a replacement for traditional hydrocarbon based polymers. PLA in particular has been successful in capturing a significant market in terms of thermoformed containers for fresh produce food packaging. Life Cycle Assessment (LCA) is a tool which relates a materials performance to its sustainability as an environmentally viable option compared to its functional contemporaries. LCA of bio-based products historically have shown favorable results in terms of environmental encumbrance and energy use when compared to petroleum based products.

The present paper is a cradle to cradle LCA of OPLA in comparison with PET and OPS thermoformed containers used for packaging of strawberries. The study has been able to address to the consideration of all the inputs like fertilizers, pesticides, herbicides and seed corn required for the growing and harvesting of corn. The study has considered global warming potential, acidification, eutrophication, fossil fuel depletion, (habitat alteration) water intake, criteria air pollution-solid particles, smog, ecological toxicity, ozone depletion, and human health as impact categories. The geographical scope of the study includes the US and the Western Europe industries.

At this point, partially analysis show that PLA resins had the least contribution towards the greenhouse gas emissions. It also had the least water consumption despite the fact that water used in the PLA manufacturing was the highest during the irrigation for corn growing in addition to the processing and cooling water. The energy consumption for PLA manufacturing was comparable to that of the petroleum based polymers. Among PET and PS, PS was found to be having higher values of water and energy use while PET contributed higher amount of carbon dioxide.

GPEC 2007 Abstract #8

Title: Title: **Recovery of Caprolactam from Nylon 6 by Catalytic Depolymerization in the Melt**
Authors: Valli Subbiah, Georgia Institute of Technology, School of Chemical and Biomolecular Engineering and Latoya Bryson, Georgia Institute of Technology, School of Chemical and Biomolecular Engineering

ABSTRACT

Nylon 6 can be depolymerized to caprolactam with high yields. This approach has been commercialized as a means to recycle nylon 6 post-consumer carpet.

The focus of this research is the assessment of catalysts and reactor design to accomplish depolymerization more efficiently. A series of base catalysts have been screened using TGA. Some of these catalysts are effective at 1 % of the nylon present. A twin screw extruder with multiple vents has been designed and installed as the depolymerization reactor. The optimization techniques employed including catalyst screening and the reactor development will be presented.