EFFECT OF TALC ON THE HOOP STRESS OF POLYPROPYLENE BLOCK COPOLYMER PIPES

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Abstract - In this study, short-term (ST) hydrostatic internal pressure (HSP) and uniaxial tensile properties of micro particulate talc (TC) filled polypropylene bloc copolymer (PPB) pipes were investigated according to the (TC) content. In general usage, it's known from the tensile tests that the TC filler in thermoplastic polymer increases the stiffness of the final product. In some recent technological achievements, the pipeline materials manufactured from single-screw production method have a variety of usage in the related sectors for their high stiffness. However, the PPB/TC composite pipe production by single screw extrusion method and the STHSP (short-term multi axial stress) effects on these products are still uncertain. Under these circumstances, the aim of this study is manufacturing TC filled PPB pipes to achieve more rigid composite pipes and optimized Hoop stress properties. To investigate the TC filler content effect on composite PPB pipes, average particle size 5.50 μm TC filler content added to polymer in different ratios of 10%, 15, 17.5 and 20 by volume. Tensile tests were applied according to ISO 6259-1 standards and short-term hydrostatic internal pressure tests applied according to ISO 1167 standards. The experimental results bring out the fact that the composites are micro particulate filled thermoplastic materials according to these standards. It was observed that the stiffness of the composite pipe was increased and the Hoop stress was decreased by the amount of the TC filler. Additionally, in order to estimate the failure mechanism, failure areas of the PPB/TC composite pipes were examined.

Keywords: Composite Pipe, Talc, Hoop Stress, Tensile properties.

Introduction

With physical modification of micro, Nano and even hybrid thermoplastic composite materials in various particle sizes, different weight percentage (wt %) amounts, and using inorganic substances as diverse as Wollastonite [1], Kaolin [2], Talc [3], and Calcium Carbonate[4], are produced. To analyze these materials high pressurized methods are used like injection molding and hot pressing, similar to their regular production method. So the studies and information gathered on the effects of the filler amount are limited with the uniaxial test results. It's known from the experimental results that, the base material and filler interaction surface characteristic, particle size and shape [5], the filler content ratio and filler distribution is affected the performance of the micro-particulate composite materials[6]. But the hydrostatic internal pressure performance of PPB/TC composite pipes which is manufactured with single screw extrusion method, keeps the uncertainty. In this context, the aim of this work is to define the performance of the PPB/TC composite pipes according to the TC filler content ratio by using the ISO 6259-1 and ISO 1167 standards. In this study regarding to ISO 6259-1, outer diameter 63mm SDR (Standard Dimension Ratio) 11 pipes which were filled with average particle size 5.50 μm and TC 10, 15, 17.5 and 20% by volume ratio tested according to the standards both ISO 6259-1 for uniaxial tensile tests and ISO 1167 for hydrostatic pressure tests at 20°C water were applied. The PPB/TC pipes were investigated according to the TC filler ratio.

Experimental

Materials

Density of 900kg/m^3 and mold flow index 0.30 g/min (230C/2,16kg) PPB material, which the commercial name is BorECO^{TM} BEC5015 (Borealis A/S), is used. The mechanical properties tested from injection molded test specimens which 1500 MPa tensile modules, yield stress 30 MPa and 10% yield elongation are some instance information for mechanical properties given by the manufacturer product data sheet according to the standard ISO 527 (Borealis 22.01.2008 Ed.9).

To investigate the filler content effect, 5.50 μm average particle size and density of 2780 Kg/m^3 TC material, which the commercial name is Talk Premier (Mikron's Mineral Endüstrisi A.Ş.), is used. The white powdered TC material producer information is given in Table 1.

Table 1 Particle Size Distribution

Particle Size	Method	Unit	Typical Value
Average dia., d(0.5)		μm	5.5
Top Cut, d(0.97) [max.]		μm	30.00
Below 2 μm [min.]		%	15
Sieve 45 μm [max.]	ISO787-7	%	1

Composite Preparation

The PPB/TC composite production is performed in (Length / Dia.) 38.5 and the screw length (L) 2700 mm twin-screwed extruder (Coperion Werner and Plederer ZSK 70 Mcc). TC mineral filler added in to granule form PP-B pipe raw material at ratios of 10%, 15%, 17.5% and 20% by volume and extruded with a twin screwed extruder machine, so mineral filled polyolefin compounds were obtained in granule form. The products were manufactured in a 500kg/h extruder at -1 bars atmospheric pressure, between 240°C-260°C zone temperatures and 28°C±3°C set cooling water. Every batch was dried at 50°C for 4 hours.

Composite Pipe Extrusion

To manufacture the pipe according to the SDR (Standard dimension ratio) 11, outer dia. 63mm pipes, screw length (L/D) 30, screw dia. (D) 90mm single screw extruder (Krauss-Maffei KME 1-90-30B) was used. Pure pipes were manufactured at 200°C-260°C zone temperatures and 25°C cooling bath temperature. Besides pure pipe production, the 10% filled PPB/TC composite pipes were manufactured at 160°C -170°C zone temperatures. And finally the 15%, 17.5%, and 20% filled PPB/TC composite pipes were can only manufactured at 155°C - 170°C zone temperatures. After the manufacturing process the pipes internal surface were rough and barbed. So, to do the experimental test on pipes, the internal and outer surfaces were milled in horizontal lathe.

Multi-Purpose Test Sample Preparation

Regarding to the ISO 6259-1 standard and as reference to ISO 3167 Type 1A multipurpose test specimens are gathered both from Pure PPB and PPB/TC composite pipes. To manufacture these test specimens a special punch die is used and the dimensions are controlled with a precise digital caliper (Mitutoyo).

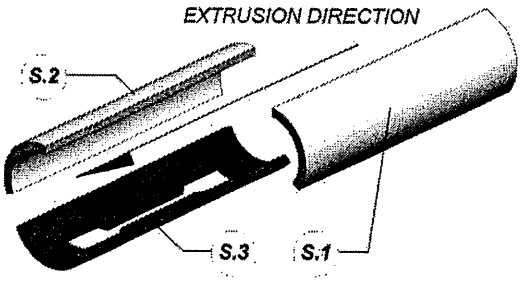


Figure 1 Preparation of tensile test samples

Tensile Test

Tensile tests were done considering ISO 527-1 with a tensile testing machine (INSTRON 4411 H 4240) which has a capacity of 5 kN with Clip-on static extensometer (INSTRON 2630-111) and Bluehill-2 version.2.6 software on it. According to ISO 527-2 standard 216 mm x 10 mm x e mm sized Type 1A tensile samples were placed in the tensile test machine. In test process 1 mm/min. tensile jaw speed used to define the Young's Modulus and 50mm/min. for other properties. Tests were done under 22°C ± 1°C temperature and 50±10% humidity and for each value at least 10 test specimens were used. Obtained values were statistically considered according to Chauvenet Criteria [7]. Results are shown in graphics based on values obtained from pure PPB pipe and changes in tensile properties are shown in graphics depending on different percentages of volume.

Hydrostatic Internal Pressure

Regarding to the test standard ISO 1167-2, from equation Eq.1 where the (D_0) outer diameter and l_2 is the testing clamp length, the sample length (l_1) was calculated 575mm.

$$l_1 = 3.D_0 + 2.l_2 + 250mm \qquad \text{Eq.1}$$

To determine the smallest wall thickness (e) beyond the pipe length, a special fixture with 0,01mm precise measuring tool (Hi-Tech) is used. To determine the pipe sample's average outer diameter (de), the outer diameter (mm) where the thinner wall is the smallest and two sides diameters are 0,01mm precisely measured with a caliper (Mitutoyo).

$$P = 10 \cdot \sigma \cdot \frac{2 \cdot e}{d_e - e} \qquad \text{Eq.2}$$

The HSP tests were done at Blue Line 1586-0212 (Institut für Prüftechnik Geraetebau GmbH & Co.KG) testing machine in Kocaeli University. Regarding to ISO 1167-1 type-A end caps were used in tests. The internal pressure (bar) applied to the pipes are calculated from Eq.2 [Where ($\sigma=\sigma_h$) indicates the Hoop stress (MPa), (d_e) average outer dia. of pipe (mm)] Pipes are stored at least 150 hours in well-conditioned and free of sunlight. The pipes are tested at 20°C±0,2°C temperature range, at calculated nominal pressure and can be diagnosis in circumstances like 1% pressure decrease and 2% pressure rise. To determine the HSP performance of the pipes at least 5 sample is used for each test.

Results and Discussion

Mainly we should note in here that pure PPB, PPB/TC composite materials were used without being exposed to the effects of the parameters used in twin-screw extrusion process. In this context, the pure and PPB PPB/TC composite pipes uniaxial tensile and HSP properties were determined. It's shown in the graphics that with 10% TC filler content, elastic modulus 37% increases, the yield stress 46% and yield elongation 46% decreasing as a result of the experiments. Moreover to 10% TC content the higher TC content (15, 17.5, and 20%) is basically raises the elastic modulus and decrease the yield elongation and yield stress.

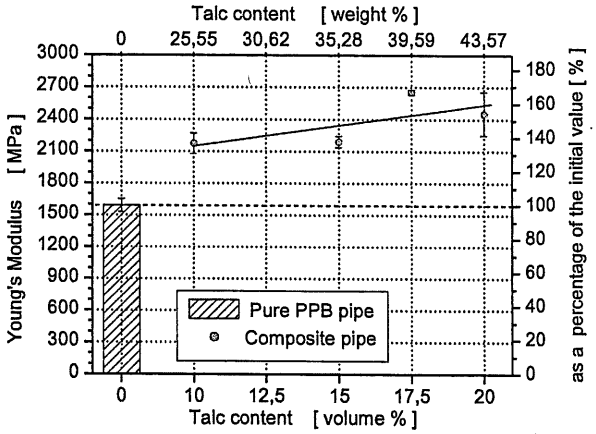


Figure 2 Elastic Modulus Properties of PPB/TC composite material against pure PPB material.

From Fig. 2 it's clearly indicated that at 15%, 17.5% and 20% TC content raises the elastic modulus in the same order of 38%, 67% and 54%. From Fig. 3 it's clearly indicated that at 15%, 17.5% and 20% TC content decreases the tensile strength in the same order of 46.6%, 56.7% and 49.4%.

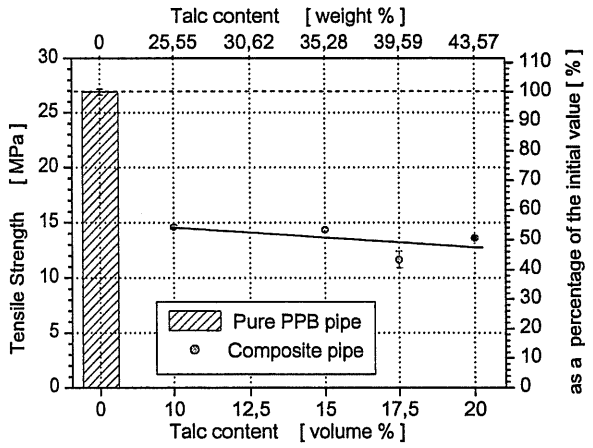


Figure 3 Tensile Strength of PPB/TC composite material against pure PPB material.

From Fig. 4 it's clearly indicated that at 15% 17.5% and 20% TC content rises decreases the tensile strain in the same order of 45%, 69.1% and 57.5%.

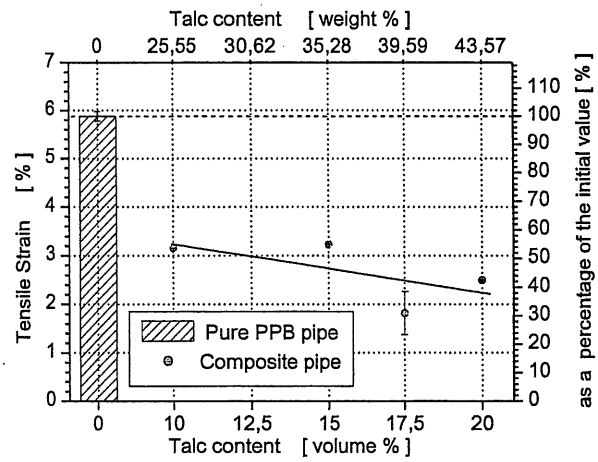


Figure 4 Tensile Strain of PPB/TC composite against pure PPB material.

Pipes, Hoop stress-time-temperature curves plotting, pure PPB pipe damage in the first hour of Hoop stress the value of 22.1 MPa, were used as the initial base value. The PPB/TC composite pipes HSP performance is evaluated as reference of 22.1MPa = 100 %. According to this reference the composite pipes Hoop stress-time-temperature curves are plotted. In Fig. 5 the short-term HSP performance of pure PPB and PPB/TC composite pipes were given. When Fig. 5 analyzed, first of all it was observed that the TC filler affected the HSP properties of the pure PPB pipe. The PPB/TC composite pipe's HSP properties are slightly lower than pure PPB pipe. On the other hand, there is approximately 22.7% contraction occurs in pure PPB depending on the time from the 1 hour to 100 hour Hoop stress values, this happens almost the same in 10% TC filled PPB/TC pipe, whereas it's figured out that the contraction occurs at PPB/TC 15%, 17.5% and 20% in the same order of 37.8%, 32.3% and 28.2%, which is significantly higher the 10% TC content.

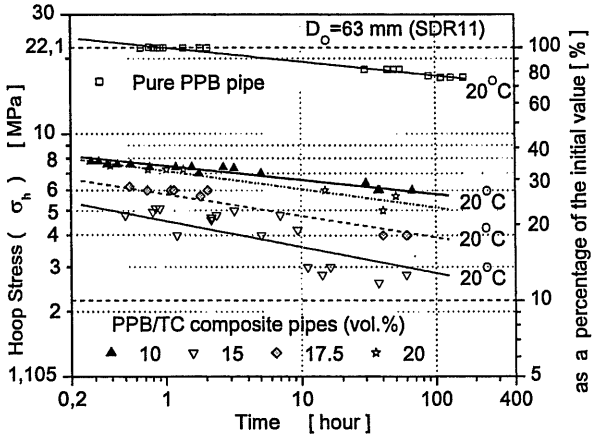


Figure 5 The Hoop stress-time-temperature curves of pure PPB and 10, 15, 17.5, 20% filled PPB/TC composite pipes.

Therefore it's determined that according to the pure PPB in 10%, 15%, 17.5% and 20% PPB/TC pipes there is a drop occurs in 1 hour Hoop stress damage values in the same order of 66.1%, 79.4%, 73.8% and 67.7%. Similar to that, it's determined according to the pure PPB in 10%, 15%, 17.5% and 20% PPB/TC pipes there is a drop occurs in 100 hour Hoop stress damage values in the same order of 66.1%, 83.4%, 77% and 70%.
As a result in this context, the 10% TC filler is affected the Hoop stress damage values less than the increasing TC filler contents. However, for 1 hour to 100 hours, under the influence of short-term HSP, and 10 percent pure PPB TC-filled composite pipe, of Hoop stress values were the same changes with time. Therefore, the amount of TC filler by volume of 10% decreases the pure PPB Hoop stress value 66.1% but its determined that there is no effect on Hoop stress in time. From tensile tests as well as 46% decrease of the yield stress value of TC filled pipe by volume 10%, the 66.1% drop of Hoop stress value in1 hour under short-term HSP effect is noteworthy. Cause under the influence of HSP, its known that Hoop stress value is two times bigger that uniaxial stress. In this case, under the HSP effect this result could be described as the TC particulates and base polymer particulates interaction surfaces were not adhere each other as required. To prepare the Hoop stress-time-temperature curves, for 20°C test temperature, regardless from the outer diameter and wall thickness of pipe, 16MPa Hoop stress value is taken as a reference from ISO 15494, at minimum required hydrostatic strength curve causes damage at 1 hour. This reference is chosen for a start value (16MPa = 100%) to demonstrate the increases or decreases by percentage in graphics. In Fig. 6 the Hoop stress-time-temperature curves, minimum required hydrostatic strength curves for PP-B (ISO15494) are given together with 10, 15, 17.5 and 20% by volume TC filled composite pipes. When Fig. 6 examined, first of all it's clearly seen that the minimum required hydrostatic strength curve for 10, 15, 17.5, 20% TC filled by volume PP-B composite pipes Hoop stress values are significantly smaller than the minimum

required hydrostatic strength curve for PP-B (ISO15494).

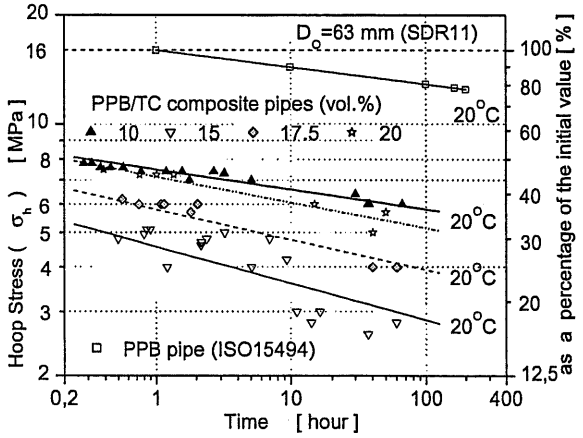
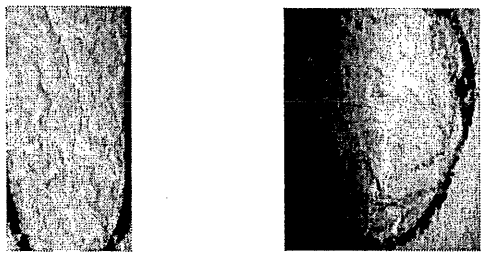


Figure 6 According to ISO15494 min. required hydrostatic strength time temperature curve for 10, 15, 17.5, 20% TC filled by volume PPB composite pipes.

From the reference standard according to the allowed value for 1 hour Hoop stress, 10, 15, 17.5, 20% TC filled by volume PP-B composite pipes Hoop stress values which occurs damage are slightly decreases in the same order of 53.2%, 72.6%, 63.8% and 55.4%. Similarly to this context, from the reference standard according to the allowed value for 100 hour Hoop stress, 10, 15, 17.5, 20% TC filled by volume PP-B composite pipes Hoop stress values which occurs damage are slightly decreases in the same order of 55.1%, 78.1%, 69.6% and 60.2%. In Fig. 7 shows the damages occurred under 1 - 100 hour short-term HSP effect. When the figures examined depended on time, ductile fractures were observed (<1 hour) in pure PPB pipe, by increasing time there were no changes in the fracture type. On the contrary the composite pipes failure shape was start with ductile (<1 hour) and later indicate a brittle failure (>1 hour).

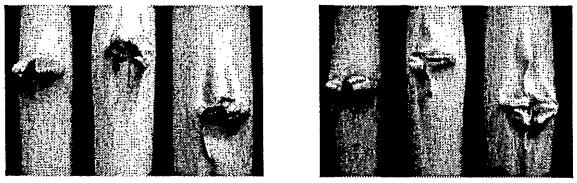
Figure 7 Failure modes depend to time.

10% by volume TC filled PPB/TC composite pipes



< 1 hour ***> 1 hour***

Pure PPB pipe



< 1 hour ***> 1 hour***

Conclusions

In this study, 1-100 hour short-term HSP performances of PPB/TC composite pipes affected by 10, 15, 17.5 and 20% TC filler content. But its determined that increasing TC content has a slightly lower effect to performance of the pipes besides the big effect of the 10% by volume TC content to pure PPB. It was recorded that the TC filler in PPB pipe by volume 10% has a significant decrease in pipes mechanical performance, also its observed that by increasing TC content the effects were decreased. Performance of composite pipes, for the standard associated with PPB pipes, within the same durations stipulated by the minimum performance, were found to be lower. Also, 10, 15, 17.5 and 20% by volume TC-filled composite pipe, between the same durations, in the same order of about 22.7%, 37.8%, 32.3% and 28.2% the amount of change in performance, for the standard associated with PPB pipes, as reference standards predict value 19.4% the amount of change in performance were also detected higher. From the Hoop stress-time-temperature curves it should be stated that the decrease in Hoop stress value of PPB/TC composite pipes under HSP stress during time is higher than the required decrease from the associated standard. Finally it's recommended to use lower TC filler in future PPB/TC composite pipe research.

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S19 - Manufacturing of Load-Carrying Hybrid Polymer Structures

S20 - Microtribology and Surface Analysis

S21 - DRG: Fundamental and Applied Rheology

S22 - Thermo-Mechanically Graded Materials

** The two symposia "Extrusion, joining, and coating" as well as "Blow molding, Thermoforming, and Rotomolding" have been combined.*

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S09 - Polymer Composites

- Keynotes
- Oral Presentations
- Poster

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S09 - Polymer Composites

Poster:

S09-1: *Bhawana Agrawal*
Single Polymer Composite made of polypropylene fabric and matrix

S09-5: *S. M. Hong, C. M. Koo*
Mechanical, Dielectrical and Electromechanical Properties of SEBS/CB and SEBS/SWCNT Nanocomposites

S09-36: *Yasuya Nakayama, Toshihisa Kajiwara*
Quantifying hierarchical mixture quality in polymer composite materials: structure and inhomogeneity in multiple scales

S09-44: *Mehmet Kodal, Hümeyra Şirin, Güralp Özkoç*
Effects of Screw Speed on the Properties of Plasticized PLA/POSS Composites

S09-89: *Jacobsen, Jens A.*
Investigating the applicability of direct analysis ion mobility for the analysis of synthetic polymers

S09-118: *K. Enomoto, S. Yoshikawa, M. Hirabayashi*
Tribological properties of PTFE composite films filled with Carbon Nanofiber

S09-135: *S. Z. Homayounfar, R. Bagheri*
Role of Different Compatibilizing Approaches on the Microstructure and Mechanical Properties of Polypropylene/Talc Composites

S09-169: *Adriana Martinelli Catelli de Souza, Luiz Alberto de Melo*
Reuse of rigid Polyurethane foam as filler for Polypropylene matrix

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S09-240: *Ch. Hopmann, M. Kerschbaum, K. Küsters*
Processing of microencapsulated dyes for the visual inspection of fibre reinforced plastics

S09-297: *D. Guo, S.B. Bai, Q. Wang*
Structure and Properties of Halogen-free Flame Retardant Poly (vinyl alcohol)/Melamine Phosphate Composites

S09-328: *V. Jankauskaitė, A. Lisauskaitė, I. Procyčevas, A. Vitkauskienė*
Structure and antibacterial properties of polydimethylsiloxane and microcrystalline cellulose composites

S09-336: *S. Mızrak, Ş. Şahin, T. Şahin*
Tensile Properties of Ground Colemanite Filled Polyamide 6.6 Composite

S09-345: *E. Fındık, Ş. Şahin*
Effect of talc on the hoop stress of polypropylene block copolymer composite pipes

S09-348: *E.G. Yıldız, Ş. Şahin, T. Şahin*
Fracture Toughness of Calcium Carbonate Filled Polypropylene Block Copolymer Composite Stored at a Place which have no daylight

S09-352: *A. Altay, H. Akten, Ş. Şahin*
Tensile Properties of Calcium Carbonate Filled Polypropylene Block Copolymer Composite Pipes

S09-353: *Ç. Yılmaz, B. Yoro, Ş. Şahin*
Effect Of Cold Drawing And Thermal Aging On Mechanical And Thermal Properties of Calcium Carbonate Filled Polypropylene Block Copolymer Composite

S09-356: *Ch. Hopmann, M. Poehler, A. Boettcher, K. Fischer, R. Schoeldgen*
Investigations on the thermoplastic fiber spraying process and the variothermal consolidation of 3D preforms

S09-392: *C. Borsoi, C. Cavinato, L.C. Scienza, A.J. Zattera*
Processing of recycled expanded polystyrene and waste newsprint fibers composites

S09-394: *S. Colomina, T. Boronat, O. Fenollar, L. Sánchez-Nacher, R. Balart*
High renewable content sandwich structures based on flax-basalt hybrids and biobased epoxy polymers

S09-464: *Hiroyuki Yamamoto, Kazushi Yamada, Hiroyuki Nishimura*
Evaluation of Long-Term Performance of Glass-Fiber Reinforced Engineering Plastics for Hot Water Supply

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S09-508: *A. L. Catto, L. S. Montagna, K. Rossini, R. M. C. Santana*
Processing of post-consumer HDPE reinforced with wood flour: effect of functionalization methodology

S09-533: *R. A. Damiani, J. Fiori Jr., J. R. Silvano, A. B. S. Santos Neto, P. H. H. Araújo, M. Peterson, M. A. Fiori*
Effect of the injection processing on the mechanical properties of the nanocoposites polyamide 6/glass fiber/montmorillonite – (PA6/GF/MMT)

S09-536: *J.E.K. Schawe, W. Possart, L. Krogh*
Solid State Rheology of Polymer Films and Layers: Influence of the Thickness on Mechanical Properties of a PU-Adhesive between Metallic Substrate

S09-540: *B. R. Moreira, F. R. Passador, L. A. Pessan*
Preparation of Polyaniline/Sodium Alanate Hybrid using a Spray-Drying Process

S09-589: *D. A. Rodrigues, A. S. M. Oliveira, R. F. Specht, R. M. C. Santana*
Development and mechanical characterization of a composite of polypropylene (PP) with grinding sludge as fiber

S09-674: *J. H. Choi, J. S. Yoo, S. Lee, S. K. Han, H. S. Kim, K. D. Lee, J. S. Shim, J. W Lee*
Optimization of Condition for Simulant of Highly-filled Energetic Materials

S09-712: *I. F. Pinheiro, L. H. I. Mei, A. R. Morales*
Polymeric biocomposites of poly (butylene adipate-co-terephthalate) reinforced with munguba natural fibers

S09-728: *G. Ozkoc, O. Gokce, M. Kasap*
Properies of biodegradable tpu/waste chicken feathers composites and their investigation of potential use as tissue engineering scaffold

S09-761: *Marcelo F.L. Oliveira, Aline L. China, Marcia G. Oliveira, Márcia C.A.M. Leite*
Preparation and characterization of composites based on polyester and starch matrix with vermiculite

S09-803: *J. Tomaszewska, T. Sterzyński, T. Żuk, K. Królikowski*
The filler shape dependent mechanical properties of wood polymer composites with polyethylene and poly(vinyl chloride) matrix

S09-842: *Ambrósio, José Donato*
Polyamide 6/Nano-Silicon Dioxide Nanocompósitos

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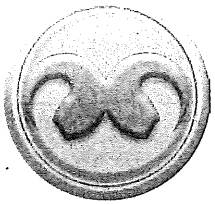
S09-844: *L.S. Lima, L.B. Gonella, J. Junges, A.J. Zattera*
Influence of different nanofillers on the thermal and mechanical properties of polypropylene

S09-880: *V. de Macedo, L.C. Scienza, A.J. Zattera, C.A. Ferreira, D. Piazza*
Influence of the addition of muscovite mica and agalmatolite on the properties of polymeric nanocomposites applied to epoxy-based powder coating

S09-901: *T-M. Süld, T. Kaljuvee*
Thermal degradation behaviours of Polyethylene reinforced with inorganic filler



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The Polymer Processing Society (PPS) was founded in March 1985 at the University of Akron, Ohio, USA. The intent was to provide a mechanism and format for interaction and presentation of research results in the international polymer processing community. The goals of PPS are to foster scientific understanding and technical innovation in polymer processing by providing a discussion forum for the worldwide community of engineers and scientists in the field. The thematic range encompasses all formulations, conversion and shaping operations applied to polymeric systems in the transformation from their monomeric forms to commercial products.

Membership for the PPS is open to all researchers in the field, and to all persons who feel the activities of the society advance their professional development.

PPS website : www.tpps.org

Founding Meeting	Akron, OH, USA, 1985
2nd	Montreal, Canada, 1986
3rd	Stuttgart, Germany, 1987
4th	Orlando, FL, USA, 1988
5th	Kyoto, Japan, 1989
6th	Nice, France, 1990
7th	Hamilton, Canada, 1991
8th	New Delhi, India, 1992
9th	Manchester, UK, 1993
10th	Akron, OH, USA, 1994
11th	Seoul, Korea, 1995
12th	Sorrento, Italy, May 27-31, 1996
13th	New York City, NY, USA, 1997
14th	Yokohama, Japan, 1998
15th	's-Hertogenbosch, The Netherlands, 1999
16th	Shanghai, China, 2000
17th	Montreal, Canada, 2001
18th	Guimaraes, Portugal, 2002
19th	Melbourne, Australia, 2003
20th	Akron, OH, USA, 2004
21st	Leipzig, Germany, 2005
22nd	Yamagata, Japan, 2006
23rd	Salvador, Brazil, 2007
24th	Salerno Italy, 2008
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28th	Bangkok, Thailand, 2012
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Massachusetts Institute of Technology, USA

Prof. Alan H. Windle
University of Cambridge, United Kingdom

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University of Mainz, Germany

Prof. Georg Steinbichler
ENGEL Austria GmbH, Austria

Prof. Helmar Franz
Haitian International Holdings Ltd., China

Dr. Manfred Schmid
Inspire AG, Switzerland

Prof. Suprakas Sinha Ray
Morand Lambla Awardee 2013

Dr. Roland Hingmann (on behalf of the award winning team)
James L. White Innovation Awardee 2013

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Polymer Nanostructures and Nanocomposites
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Natural Based and Biodegradable Polymers
Christian Bonten (Germany), David Grewell (USA), Rowan Truss (Australia), Elmar Moritzer (Germany)

Polymer Foams
Christian Hopmann (Germany), Chul Park (Canada), Masahiro Ohshima (Japan), Roberto Pantani (Italy)

Polymer Composites
Alois Schlarb (Germany), Jingshen Wu (Hong-Kong), Paolo Ermanni (Switzerland), Ashok Misra (India), Andreas Spörrer (Germany)

Elastomers and Thermoplastic Elastomers
Gert Heinrich (Germany), Kinsuk Naskar (India), Tony McNelly (UK)

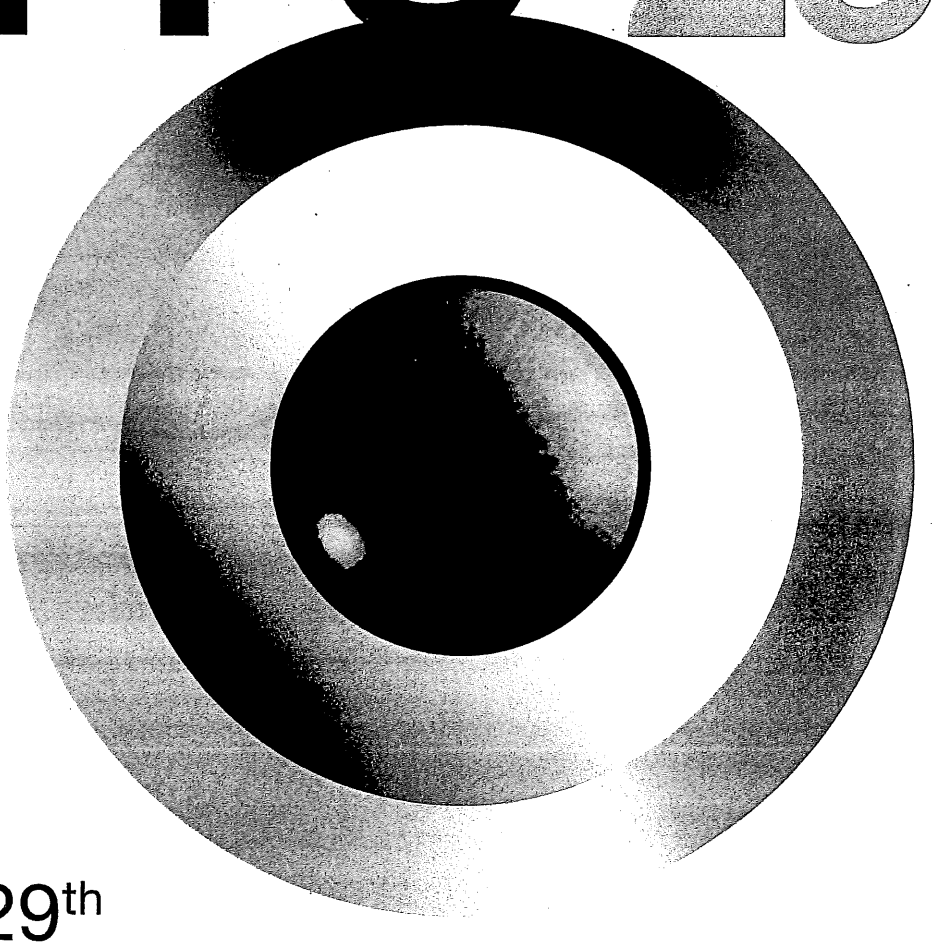
Modeling and Simulation
Johannes Wortberg (Germany), John Vlachopoulos (Canada), Rahul Gupta (Australia), Jean-Francois Agassant (France)

Polymer Blends
Hans-Joachim Radusch (Germany), Uttandaraman Sundararaj (Canada), Jozsef Karger-Kocsis (Hungary), Kiyohito Koyama (Japan)

Reactive Processing
Edmund Haberstroh (Germany), Costas Tzoganakis (Canada), Jin Kon Kim (South Korea), Phillipe Cassagnau (France)

Special Symposia
Dietmar Drummer, Werner Hufenbach, Wolfgang Weinhold, Norbert Willenbacher, Volker Altstädt (Germany)

PPS 29



29th International Conference of the

POLYMER PROCESSING SOCIETY

JULY 15 – 19, 2013

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