Amar K. MOHANTY, Ph.D, FAIChE, FSPE, FRSC(UK), FRSC(Canada)

Director, Bioproducts Discovery & Development Centre (BDDC)
OAC Distinguished Research Chair in Sustainable Biomaterials
Professor, Department of Plant Agriculture & School of Engineering
Editor-in-Chief of Sustainable Composites, Composites Part C - Open Access
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www.plant.uoguelph.ca/research/homepages/amohanty/

EDUCATION AND DEGREES

Ph.D.	Utkal University	Chemistry Area: Polymers & Natural Fibers	1987
M.Sc.	Utkal University	Chemistry, Specialization: Polymer Chemistry	1980
B.Sc.	Utkal University	Chemistry Honours with Distinction	1978

POSITIONS HELD

2008 – Present	**Professor,** Department of Plant Agriculture and School of Engineering (Cross-appointed), University of Guelph, Canada
2020 – Present	**OAC Distinguished Research Chair in Sustainable Biomaterials** University of Guelph, Canada
2008 – Present	**Director,** Bioproducts Discovery & Development Centre (BDDC), Canada
2020 – Present	**Fellow,** Royal Society of Canada, Canada
2019 – Present	**Fellow,** Royal Society of Chemistry, UK
2019 – Present	**Fellow,** Society of Plastics Engineers, USA
2018 – Present	**Fellow,** American Institute of Chemical Engineers (AIChE), USA
2007 – Present	**Director/Executive Committee Member,** American Institute of Chemical Engineers: Forest Product Division, USA
2017 – 2020	**Research Leadership Chair,** University of Guelph, Canada
2008 – 2020	**Premier's Research Chair in Biomaterials & Transportation**, University of Guelph, Canada
2003 – 2008	**Associate Professor,** Michigan State University, USA
2001 – 2003	**Visiting Associate Professor,** Michigan State University, USA
2000 – 2001	**Visiting Research Associate,** Michigan State University, USA
1999 – 1999	**Post-Doctoral Associate,** Iowa State University, USA
1998 – 1999	**Alexander von Humboldt Fellow,** Technical University of Berlin, Germany
1987 – 1997	**Lecturer & Senior Lecturer (Chemistry),** Government Colleges affiliated with Berhampur & Utkal University, India

CURRENT RESEARCH AREAS

Biobased Materials, Renewable Resource-Based Materials, Biocarbon-Based Biocomposites, Natural Fiber Composites, Biodegradable and Biobased Polymers, Nanoblends, Nanocomposites, Value-Added Biomaterials from the Byproducts and Coproducts of the Biofuel Industries (Advanced Biorefinery), Recyclability, Durability and Biodegradability Studies of Bioplastics and Biobased Materials, Pyrolysis of Biomass and Waste Streams, 3D Printed Biobased Materials, Sustainable Biomaterials, Circular Economy.

RESEARCH IMPACT (800+ Publications)

Google Scholar Citations: 37,913; h-index: 87; i10-index: 358 (Mar. 10, 2021).
ResearchGate (RG) Score: 47.39 (higher than 97.5% of RG members) (Mar. 10, 2021).

- 415 peer-reviewed journal papers (including accepted/in press papers)
- 67 Patents: 25 Awarded, 42 Applications, 5 license agreements
- 5 edited books and 21 book chapters
- Supervised 232 students, staff, and trainees
- Research Presentations: 84 Plenary/Keynote & 43 Invited
- 300+ Conference Presentations (Presented by Prof. Mohanty & Trainees)
- 5 commercial products in the market
- Over $35M in research and infrastructure cash funding

AWARDS, HONOURS AND DISTINCTIONS

2020 – Present	**Fellow,** Royal Society of Canada (RSC), Canada
2020 – Present	**OAC Distinguished Research Chair in Sustainable Biomaterials**, University of Guelph, Canada
2019 – Present	**Fellow**, Royal Society of Chemistry (RSC), UK
2019 – Present	**Fellow**, Society of Plastics Engineers (SPE), USA
2018 – Present	**Fellow**, American Institute of Chemical Engineers (AIChE), USA.
2020	**JL White Innovation Award**, International Polymer Processing Society
2017 – 2020	**Research Leadership Chair Award**, University of Guelph, Canada
2008 – 2020	**Premier's Research Chair in Biomaterials & Transportation**, University of Guelph, Canada (Endowed Research Chair awarded for 12 years)
2019	**Biju Patnaik Award for Scientific Excellence**, Odisha Bigyan Academy, India
2019	**OAC Alumni Distinguished Researcher Award**, University of Guelph, Canada
2018	**NSERC Synergy Award for Innovation**, Natural Sciences and Engineering Research Council, Canada
2017	**Highly Prolific Author**, American Chemical Society (ACS) Sustainable Chemistry & Engineering, USA
2017	**Featured Canadian Author**, Selected for ACS Publications Open Access Virtual Issue "Hot Materials in a Cool Country" - articles authored by Canadians to celebrate the 100th Canadian Chemistry Conference
2016	**Innovation of the Year Award,** University of Guelph, Canada For the creation of the 100% Compostable Bio-composite Resin; additional awards for this innovation at: http://purpod100.com/awards/
2015	**Lifetime Achievement Award**, BioEnvironmental Polymer Society, USA
2012	**"Gold Medal" and Certificate**, International Conference on Composites Interfaces, (Interface21).
2011	**Jim Hammar Memorial Service Award**, BioEnvironmental Polymer Society, USA
2011 – 2015	**5 Year Visiting Professorship**, South China University, China
2006	**Andrew Chase Forest Products Division Award**, American Institute of Chemical Engineers, USA
1998 – 1999	**Alexander von Humboldt Fellowship**, AvH Foundation, Germany

INTERNATIONAL LEADERSHIP ACTIVITIES, SERVICES & MEMBERSHIPS

Editorial Board for Peer-reviewed Journals

2020 – Present	**Editor-in-Chief** *in Sustainable Composites***:** Composites Part C: Open Access, *Elsevier*
2014 – Present	**Member:** American Institute of Mathematical Sciences (AIMS) Energy, *AIMS Press*
2013 – Present	**Member:** International Journal of Plastics Technology, *Springer*
2013 – Present	**Member:** Journal of Renewable Materials, *Tech Science Press*
2013 – Present	**Member:** International Journal of Precision Engineering and Manufacturing – Green Technology, *Springer*
2013 – 2016	**Member:** Journal of Nanoscience and Nanotechnology, *American Scientific Publishers*
2013 – 2016	**Member:** Journal of Polymers and Environment, *Springer*
2013 – 2015	**Member:** Polimery, *Industrial Chemistry Research Institute*
2007 – 2014	**Editor-in-Chief**: Journal of Biobased Materials and Bioenergy, *American Scientific Publishers*
2013	**Guest Editor:** Conference Proceedings, International Conference on Natural Fibers—Sustainable Materials for Advanced Applications 2013, *Hindawi Publishing Corporation*
2012 – 2013	**Guest Editor:** Journal Advances in Mechanical Engineering: Natural Fiber Composites, *Hindawi Publishing Corporation*
2010 – 2011	**Honorary Editor:** Advanced Materials Letters, *VBRI Press*

Book Editor

2017	"Fibre Technology for Fiber Reinforced Composites", Woodhead Publishing Limited.
2015	"Biocomposites: Design and Mechanical Performance", Woodhead Publishing Limited.
2014	"Handbook of Polymer Nanocomposites. Processing, Performance and Application: Volume A: Layered Silicates", Springer.
2009	"Packaging Nanotechnology", American Scientific Publisher (2009).
2005	"Natural Fibers, Biopolymers and Biocomposites", CRC Press, Taylor & Francis Group, Boca Raton, FL.

American Institute of Chemical Engineers (AIChE), USA

2007 – Present	**Director/Executive Committee Member**: Forest and Plant Bioproducts (formerly Forest Product) Division
2017 – 2018	**Chair of Awards Committee**
2005 – 2019	**Session Chair**: AIChE Annual Meetings

BioEnvironmental Polymer Society (BEPS), USA

2017	Chair of Awards Committee
2014	Session Chair: BEPs Annual Meeting
2011	President
2010	Organizer: BEPS Annual Meeting

United States Department of Agriculture (USDA), USA

2020 Review Panel Member

National Science Foundation (NSF), USA

2013 Review Panel Member: Sustainable Chemistry, Engineering and Materials Division

Natural Sciences and Engineering Research Council (NSERC), Canada

2016, 2017 Research Tools and Instruments (RTI) Grants Selection Committee
2013, 2016 Grant Review, NSERC Discovery Grants
2011 – 2014 Review Panel Member, Strategic Grants
2009 – 2015 Project Leader, AUTO21-NCE (National Centre of Excellence)

University of Guelph, Canada

2017 Panel Member: Equipment Grants Selection Committee, School of Engineering

External Reviewer for Promotions

(From Assistant Professors to Associate Professors, from Associate Professor to Full Professor and Distinguished Professorship)

USA

2018	Stony Brook University, New York
2017	Rowan University, New Jersey
2017	Clemson University, South California
2014, 2016	Washington State University, Washington
2015, 2016	Florida State University, Florida
2015	University of Massachusetts Lowell
2012	University of North Texas, Texas
2012,2013	University of Wisconsin, Madison
2010	University of Wisconsin, Milwaukee

Canada

2017	University of Alberta
2013	University of Toronto
2010, 2014	University of British Columbia

Europe

2018	University of Portsmouth, United Kingdom
2005	Imperial College, London

Advisory Board Member

2008 – Present Ontario Ministry of Agriculture, Food & Rural Affairs (OMAFRA) Bioeconomy Branch

Conference Chair

2020 Virtual Circular Economy Workshop 2020: Sustainable Materials – Innovating Our Future Beyond the Pandemic, Guelph, Ontario, Canada. September 23-24, 2020.

2018 15th International Symposium on Bioplastics, Biocomposites & Biorefining, Guelph, Ontario, Canada. July 24 – 27, 2018.

2016 14th International Symposium on Bioplastics, Biocomposites & Biorefining. Guelph, Ontario, Canada. May 31 – June 3, 2016.
2014 13th International Symposium on Bioplastics, Biocomposites & Biorefining. Guelph, Ontario, Canada. May 19 – 24, 2014.
2012 12th International Conference on Biocomposites. Niagara Falls, Ontario, Canada. May 6 – 8, 2012.

Conference Session Chair

2002 – 2019 American Institute of Chemical Engineers (AIChE) Annual Meeting Forest Bioproduct Division, USA. Multiple sessions every year
2001 – 2019 BioEnvironmental Polymer Society (BEPS) Annual Meeting, USA.
2013 International Conference on 'Global Challenges and Prospects of Jute and Allied Fibres', Kolkata, India
2013 International Conference on Natural Fibres. Guimaraes, Portugal.
2013 International Symposium on Green Manufacturing and Applications. Honolulu, Hawaii, USA.
2012 12th International Conference on Biocomposites. Niagara Falls, Ontario, Canada.
2011 International Conference on Advancements in polymeric Materials. Chennai, India.
2010 International Symposium on Renewable Feedstocks for Biofuel and Bio-based Products. Austin, Texas, USA.
2010 18th Annual Conference on Polymers and the Environment: Emerging Green Technologies & Sciences. Toronto, Ontario, Canada.

PUBLICATIONS

Selected Featured Publications

1. Featured in Green Chemistry Editor's Choice
   Meereboer, K., Misra, M., & **Mohanty, A.K.** (2020). "Review of recent advances on biodegradability of polyhydroxyalkanoate (PHA) bioplastics and their green composites". *Green Chemistry*, 22 (17), 5519-5558.
2. Featured cover page: Physical Chemistry Chemical Physics (28 June 2018, Issue 24)
   Pin, J.-M, Behazin, E., Misra, M., & **Mohanty, A.K.** (2018). "Stereodynamic insight of the thermal history effect on poly(vinyl chloride) calorimetric sub-glass and glass transitions as fragile glass model". *Physical Chemistry Chemical Physics*, 20, 16333-16346.
3. Featured Article in Advances in Engineering (AIE) (2017)
   Pin, J. M., Valerio, O., Misra, M., & **Mohanty, A.** (2017). "Impact of butyl glycidyl ether comonomer on poly (glycerol–succinate) architecture and dynamics for multifunctional hyperbranched polymer design". *Macromolecules*. 50 (3), 732-745.
4. Featured 2 ACS Publications Open Access Virtual Issue "Hot Materials in a Cool Country"
   i. Mashouf Roudsari, G., **Mohanty, A.K.**, & Misra, M. (2017). "Exploring the effect of poly (propylene carbonate) polyol in biobased epoxy interpenetrating network". *ACS Omega*, 2(2),611-617.

ii. Nagarajan, V., **Mohanty, A.K.**, & Misra, M. (2016). "Perspective on polylactic acid (PLA) based sustainable materials for durable applications: Focus on toughness and heat resistance". *ACS Sustainable Chemistry & Engineering*, 4(6), 2899-2916.

Top 15 Most Cited Publications (ref. Google Scholar Citations, Mar. 10, 2021)

1. **Mohanty, A.K.**, Misra, M., & Hinrichsen, G. (2000). "Biofibres, biodegradable polymers and biocomposites: an overview". *Macromolecular Materials and Engineering*, 276(1), 1-24. ***Cited by 3228.***
2. **Mohanty, A.K.**, Misra, M., & Drzal, L.T. (2002). "Sustainable bio-composites from renewable resources: opportunities and challenges in the green materials world". *Journal of Polymers and the Environment*, 10(1-2), 19-26. ***Cited by 2258.***
3. **Mohanty, A.K.**, Misra, M., & Drzal, L.T. (2005). "Natural Fibers, Biopolymers and Biocomposites". *CRC Press*. ***Cited by 2182.***
4. Joshi, S.V., Drzal, L.T., **Mohanty, A.K.**, & Arora, S. (2004). "Are natural fiber composites environmentally superior to glass fiber reinforced composites?". Composites Part A: Applied Science and Manufacturing, 35(3), 371-376. ***Cited by 2037.***
5. **Mohanty, A.K.**, Misra, M., & Drzal, L.T. (2001). "Surface modifications of natural fibers and performance of the resulting biocomposites: an overview". *Composite Interfaces*, 8(5), 313-343. ***Cited by 997.***
6. Mishra, S., **Mohanty, A.K.**, Drzal, L.T., Misra, M., Parija, S., Nayak, S. K., & Tripathy, S.S. (2003). "Studies on mechanical performance of biofibre/glass reinforced polyester hybrid composites". *Composites Science and Technology*, 63(10), 1377-1385. ***Cited by 860.***
7. Reddy, M.M., Vivekanandhan, S., Misra, M., Bhatia, S. K., & **Mohanty, A.K.** (2013). "Biobased plastics and bionanocomposites: Current status and future opportunities". *Progress in Polymer Science*, 38(10), 1653-1689. ***Cited by 794.***
8. Huda, M.S., Drzal, L.T., **Mohanty, A.K.**, & Misra, M. (2008). "Effect of fiber surface-treatments on the properties of laminated biocomposites from poly (lactic acid) (PLA) and kenaf fibers". *Composites Science and Technology*,68(2), 424-432. ***Cited by 679.***
9. Rout, J., Misra, M., Tripathy, S.S., Nayak, S.K., & **Mohanty, A.K.** (2001). "The influence of fibre treatment on the performance of coir-polyester composites". *Composites Science and Technology*, 61(9), 1303-1310. ***Cited by 556.***
10. Huda, M.S., Drzal, L.T., **Mohanty, A.K.**, & Misra, M. (2006). "Chopped glass and recycled newspaper as reinforcement fibers in injection molded poly (lactic acid) (PLA) composites: a comparative study". *Composites Science and Technology*, 66(11), 1813-1824. ***Cited by 492.***
11. Zampaloni, M., Pourboghrat, F., Yankovich, S.A., Rodgers, B.N., Moore, J., Drzal, L.T., **Mohanty, A.K.**, & Misra, M. (2007). "Kenaf natural fiber reinforced polypropylene composites: a discussion on manufacturing problems and solutions". *Composites Part A: Applied Science and Manufacturing*, 38(6), 1569-1580. ***Cited by 488.***
12. **Mohanty, A.K.**, Khan, M.A., & Hinrichsen, G. (2000). "Surface modification of jute and its influence on performance of biodegradable jute-fabric/Biopol composites". *Composites Science and Technology*, 60(7), 1115-1124. ***Cited by 461.***
13. Mishra, S., **Mohanty, A.K.**, Drzal, L.T., Misra, M., & Hinrichsen, G. (2004). "A review on pineapple leaf fibers, sisal fibers and their biocomposites". *Macromolecular Materials and Engineering*, 289(11), 955-974. ***Cited by 378.***

14. Nagarajan, V., **Mohanty, A.K.**, & Misra, M. (2016). "Perspective on polylactic acid (PLA) based sustainable materials for durable applications: Focus on toughness and heat resistance". *ACS Sustainable Chemistry & Engineering*, 4(6), 2899-2916. ***Cited by 369.***
15. **Mohanty, A.K.**, Khan, M.A., & Hinrichsen, G. (2000). "Influence of chemical surface modification on the properties of biodegradable jute fabrics—polyester amide composites". *Composites Part A: Applied Science and Manufacturing*, 31(2), 143-150. ***Cited by 365.***

List of Published Edited Books

5. Seydibeyoglu, M.O., **Mohanty, A.K.**, & Misra, M. (2017). "Fiber technology for fiber reinforced composites", *Woodhead Publishing*.
4. Misra, M., Pandey, J., & **Mohanty, A.K.** (2015). "Biocomposites: Design and mechanical performance", *Woodhead Publishing*.
3. Pandey, J.K., Reddy, K.R., **Mohanty, A.K.**, & Misra, M. (2014). "Handbook of polymer nanocomposites. processing, performance and application: Volume A: Layered silicates", *Springer – Berlin, Heidelberg*.
2. **Mohanty, A.K.**, Misra, M., & Nalwa, H.S. (2009). "Packaging Nanotechnology". *American Scientific Publishers*.
1. **Mohanty, A.K.**, Misra, M., & Drzal, L.T. (2005). "Natural Fibers, Biopolymers and Biocomposites". *CRC Press*.

RECENT KEYNOTE & PLENARY PRESENTATIONS

1. **Mohanty, A.K.** (2021). "Improved utilization of coproduct from 2G biofuel production: Lignin based biomaterials in new industrial uses for a sustainable biorefinery". 2G Biofuels: A Way Forward. February 24-26, 2021. (Keynote).
2. **Mohanty, A.K.** (2020). "Circular economy and sustainable materials". Virtual AIChE Annual Meeting 2020. November 16-20, 2020. (Plenary).
3. **Mohanty, A.K.** (2020). "Innovation in bioplastic and sustainable composites through circular economy approach: Future is now in alleviating climate change impact". International Online Conference on Macromolecules 2020 (ICM2020). November 13-15, 2020. (Plenary).
4. **Mohanty, A.K.** (2020). "Biodegradable food packaging and sustainability". Vaishwik Bharatiya Vaiyanik Summit (VAIBHAV Summit) Virtual. October 15, 2020. (Panel)
5. **Mohanty, A.K.** (2020) "Sustainable materials management and the circular economy". Society of Plastics Engineers (SPE) Automotive Composites Conference & Exhibition (ACCE) Virtual Event. September 9-11, 2020. (Panel)
6. **Mohanty, A.K.** (2019). "Circular Economy Driven Sustainable Composites: Future is Now for Innovation and the Opportunities in Mitigating Climate Change". 5th International Symposium on Advances in Sustainable Polymers. Kyoto, Japan. October 14-18, 2019. (Plenary).
7. **Mohanty, A.K.** (2019) "Advances in Sustainable Composites for Automotive Applications". SPE Automotive Composites Conference & Exhibition (ACCE), Novi, Michigan, USA. September 4-6, 2019. (Keynote).
8. **Mohanty, A.K.** (2019) "What We Can Learn from Other Industries". SPE Automotive Composites Conference & Exhibition (ACCE), Novi, Michigan, USA. September 4-6, 2019. (Plenary).
9. **Mohanty, A.K.** (2019) "Sustainable composites for green manufacturing: recent developments and innovations through circular approach" 26th BioEnvironmental Polymer

Society (BEPS) Annual Meeting 2019. Greenville, South Carolina, USA. June 5-7, 2019. (Plenary).

10. **Mohanty, A.K.** (2019) "Biobased Materials from Sustainable Resources - A Circular Approach towards Alleviating Climate Change" 35th International Conference of the Polymer Processing Society (PPS-35) Annual Meeting. Cesme-Ismir, Turkey. May 26-30, 2019. (Plenary).
11. **Mohanty, A.K.** (2018) "Circular Economy for Bio-based Composites: from Research to Commercialization". Biocomposites for Technical Applications Workshop. London, Ontario, Canada. October 25 – 26, 2018. (Keynote).
12. **Mohanty, A.K.** (2018) "Going Green: Circular Economy in Exploring Innovation of Biobased Materials". International Conference on Bioinspired and Biobased Chemistry & Materials (NICE 2018). Nice, France. October 14 – 17, 2018. (Plenary).
13. **Mohanty, A.K.** (2018) "Innovation and commercialization of biocarbon for advanced green manufacturing" 25th BioEnvironmental Polymer Society (BEPS) Annual Meeting 2018. New York, USA. August 15-17, 2018. (Keynote).
14. **Mohanty, A.K.** (2018) "Renewable Resourced-based Materials towards Improved Sustainability through a Circular Economy Path: Light-weight Car Parts to Ecofriendly Packaging". Third International Symposium on Materials from Renewables (ISMR). Fargo, North Dakota, USA. July 17-18, 2018. (Keynote).
15. **Mohanty, A.K.** (2018) "Food Waste for Value-added Bio-based Materials – A Circular Approach". 5th International ISEKI_Food Conference (ISEKI_Food 2018). Stuttgart, Germany. July 3-5, 2018. (Keynote).
16. **Mohanty, A.K.** (2018) "Circular Economy: A Sustainable path forward for Bioplastics and Biocomposites Innovation" Fourth International Symposium in Sustainable Polymers (ASP17). Guwahati, Assam, India. January 8 – 11, 2018. (Keynote).
17. **Mohanty, A.K.** (2017) "Circular Economy: A Path Towards Innovation and Commercialization of Biocomposites for Sustainable Manufacturing". 2017 American Institute of Chemical Engineers (AIChE) Annual Meeting. Minneapolis, Minnesota, USA. October 29 – November 3, 2017. (Keynote).
18. **Mohanty, A.K.** (2017) "Circular Economy Based Sustainable Bioproducts for Commercialization". 24th BioEnvironmental Polymer Society (BEPS) Annual Meeting 2017. Albany, California, USA. September 20-22, 2017. (Keynote).
19. **Mohanty, A.K.** (2017) "Circular Economy: A Path Towards Innovating Biobased Materials". Circular Economy Workshop – Towards Mitigating Climate Change. Guelph, Ontario, Canada. May 5, 2017. (Keynote).
20. **Mohanty, A.K.** (2016) "Future Opportunities for Ontario's Circular Economy". Research and Innovation Bioeconomy Research and Innovation Forum. Guelph, Ontario, Canada. October 24, 2016. (Keynote).
21. **Mohanty, A.K.** (2016). "Biodegradable Green Nanocomposites in Food Packaging Uses for a Sustainable Future". 7th Annual Nano Ontario Conference 2016, Guelph, Canada-Ontario. (Keynote).
22. **Mohanty, A.K.** (2016). "Biobased Plastics and Biocomposites in Biodegradable and Durable Uses-A Path towards a Circular Economy". 14th International Symposium on Bioplastics, Biocomposites & Biorefining (ISBBB14). Guelph, Canada-Ontario. (Keynote).
23. **Mohanty, A.K.** (2016). "Sustainable lightweight carbonaceous green composites from pyrolyzed biochar: Opportunities in green automotive parts uses". BioWorld Congress 2016. San Diego, California, USA. (Keynote).

24. **Mohanty, A.K.** (2016). "Reinvention of biocomposites success in real applications: Advanced bio refinery and sustainable manufacturing". Canada-Japan-Vietnam Workshop on Composites. Ho Chi Minh, Vietnam. (Keynote).
25. **Mohanty, A.K.** (2016). "Low cost ligno-cellulosic biomass and biofuel co-products for sustainable manufacturing: challenges and opportunities". Association for Advancement of Industrial Crops (AAIC) annual meeting, Lubbock, Texas. (Keynote).
26. **Mohanty, A.K.** (2016). "Biocarbon Applications- Current Status and Future Directions". 2016 AIChE Annual Meeting. San Francisco, California. November 13, 2016. (Keynote).

SUMMARY OF PATENTS

Prof. Mohanty has published a lifetime total of 67 patents. Out of the 67 patents, 25 patents have been granted, while 42 patents are in the application stage. During Prof. Mohanty's tenure at the University of Guelph, a total of five patents have been licensed for commercial uses.

List of Granted Patents

25. **Mohanty, A.K.**, Misra, M., Behazin, E., & Rodriguez-Uribe, A. "Toughened polyolefin and biocarbon based light weight biocomposites and method of making the same". Publication Number: US10472440B2. Publication Date: November 12, 2019.
24. **Mohanty, A.K.**, Misra, M., Bali, A., & Rodriguez-Uribe, A. "Renewable Replacements for Carbon Black in Composites and Methods of Making and Using Thereof". Publication Number: US10414880B2. Publication Date: September 17, 2019.
23. **Mohanty, A.K.**, Yuryev, Y., & Misra, M. "Durable high performance heat resistant polycarbonate (PC) and polylactide (PLA) blends and compositions and methods of making those". Publication Number: US9920198B2. Publication Date: March 20, 2018.
22. **Mohanty, A.K.**, Misra, M., Rodriguez-Uribe, A., & Vivekanadhan, S. "Hybrid Sustainable Composites and Methods of Making and Using Thereof". Publication Number: US9809702B2. Publication Date: November 7, 2017.
21. Misra, M., Vadori, R. & **Mohanty, A.K.** "Bio-Based Acrylonitrile Butadiene Styrene (ABS) Polymer Compositions and Methods of Making and Using Thereof". Publication Number: US9562156B2. Publication Date: February 7, 2017.
20. **Mohanty, A.K.**, Misra, M., & Sahoo, S. "Lignin Based Materials and Methods of Making Those". Publication Number: US9309401B2. Publication Date: April 12, 2016.
19. **Mohanty, A.K.**, Drzal, L.T., Rook, B.P., & Misra, M. "Environmentally Friendly PolyLactide-Based Composite Formulations". Publication Number: CA2427012C. Publication Date: April 3, 2012.
18. **Mohanty, A.K.**, Wu, Q., & Singh, A. "Bioadhesive from distillers' dried grains with solubles (DDGS) and the methods of making those". Publication Number: US7837779B2. Publication Date: November 23, 2010.
17. **Mohanty, A.K.**, Selke, S., & Wu, Q. "Novel "green" materials from soy meal and natural rubber blends". Publication Number: US7649036B2. Publication Date: January 19, 2010.
16. **Mohanty, A.K.**, Wu, Q., & Singh, A. "Bioadhesive from distillers' dried grains with solubles (DDGS) and the methods of making those". Publication Number: US7618660B2. Publication Date: November 17, 2009.
15. **Mohanty, A.K.**, Parulekar, Y., Chidambarakumar, M., Kositruangchai, N., & Harte, B.R. "Biodegradable polymeric nanocomposite compositions particularly for packaging". Publication Number: US7619025B2. Publication Date: November 17, 2009.

14. **Mohanty, A.K.**, Tummala, P., Misra, M., & Drzal, L.T. "Filler Reinforced Thermoplastic Compositions and Process for Manufacture". Publication Number: US7582241B2. Publication Date: September 1, 2009.
13. **Mohanty, A.K.** & Bhardwaj, R. "Hyperbranched polymer modified biopolymers, their biobased materials and process for the preparation thereof". Publication Number: US7579413B2. Publication Date: August 25, 2009.
12. Drzal, L.T., **Mohanty, A.K.**, Liu, W., Thayer, K., & Misra, M. "Cellulosic Biomass Soy Flour Based Biocomposites and Process for Manufacturing Thereof". Publication Number: US7576147B2. Publication Date: August 18, 2009.
11. **Mohanty, A.K.** & Parulekar, Y. "Methods of making nanocomposites and compositions of rubber toughened polyhydroxyalkanoates". Publication Number: US7420011B2. Publication Date: September 2, 2008.
10. **Mohanty, A.K.**, Drzal, L.T., Rook, B.P., & Misra, M. "Floor Covering Made from an Environmentally Friendly Polylactide-Based Composite Formulation". Publication Number: US7354656B2. Publication Date: April 8, 2008.
9. **Mohanty, A.K.**, Drzal, L.T., Rook, B.P., & Misra, M. "Environmentally Friendly PolyLactide-Based Composite Formulations". Publication Number: US7256223B2. Publication Date: August 14, 2007.
8. **Mohanty, A.K.**, Drzal, L.T., Rook, B.P., & Misra, M. "Environmentally Friendly PolyLactide-Based Composite Formulations". Publication Number: DE60307536T2. Publication Date: August 9, 2007.
7. **Mohanty, A.K.**, Drzal, L.T., Park, H., Misra, M., & Wibowo, A.C. "Compositions of Cellulose Esters and Layered Silicates and Process for the Preparation Thereof". Publication Number: US7253221B2. Publication Date: August 7, 2007.
6. Burgueno, R., **Mohanty, A.K.**, & Quagliata, M.J. "Hybrid natural-fiber composites with cellular skeletal structures". Publication Number: US7232605B2. Publication Date: June 19, 2007.
5. Drzal, L.T., Mehta, G., Misra, M., **Mohanty, A.K.**, & Thaer, K. "Biocomposites Sheet Molding and Methods of Making Those". Publication Number: US7208221B2. Publication Date: April 24, 2007.
4. **Mohanty, A.K.**, Drzal, L.T., Rook, B.P., & Misra, M. "Environmentally Friendly PolyLactide-Based Composite Formulations". Publication Number: DK1361039T3. Publication Date: December 27, 2006.
3. Dwan'Isa, J.P.L., Drzal, L.T., **Mohanty, A.K.**, & Misra, M. "Polyol Fatty Acid Polyesters Process and Polyurethanes Therefrom". Publication Number: US7125950B2. Publication Date: October 24, 2006.
2. **Mohanty, A.K.**, Drzal, L.T., Rook, B.P., & Misra, M. "Environmentally Friendly PolyLactide-Based Composite Formulations". Publication Number: EP1361039B1. Publication Date: August 16, 2006.
1. **Mohanty, A.K.**, Drzal, L.T., Rook, B.P., & Misra, M. "Environmentally Friendly PolyLactide-Based Composite Formulations". Publication Number: US6869985B2. Publication Date: March 22, 2005.

SUMMARY OF INNOVATIONS

1. BIOCARBON BIOCOMPOSITES FOR HIGH BARRIER COMPOSTABLE PACKAGING

Description:

Professors Mohanty and Misra were first to demonstrate that biocarbon significantly improves barrier properties when used as a filler in composite materials. Experimentally, they established that biocarbon acts as an oxygen scavenger to improve oxygen barrier of biodegradable polymers and blends (Provisional Patent Ser. No. 63/025,607). When used in biocomposites, biocarbon provides excellent oxygen barrier, which becomes superior to that of ethylene vinyl alcohol (EVOH). The significance of the work is that it enables manufacturing of fully compostable materials, including compostable sheets, single- and multi-layer films, injection moulded or thermoformed shapes. This invention will enable a huge expansion for biodegradable polymers which presently cannot be used in applications requiring high oxygen barrier. Therefore, fully compostable barrier packaging products, previously not possible, can become reality, including films, pouch bags, and other containers for oxygen-sensitive content, including pharmaceuticals.

Background:

Plastic packaging with high oxygen and water barrier has benefit in our daily life by offering stable and extended shelf-life to many packed foods in the market. To achieve high gas and water barrier, multi-layer structure films developed from non-biodegradable petroleum-based polymers are commonly used. The multi-layer structures are believed to hamper the recyclability of those packaging materials, as mono-materials of high purity are needed for reprocessing. For example, multi-layer films of polypropylene and polyethylene terephthalate (PP/PET) are used in the packaging of pharmaceutical products in which the PP provides excellent water barrier while PET provides excellent oxygen barrier. Another example is ethylene vinyl alcohol (EVOH) which was normally incorporated into multi-layer structures for food packaging to provide excellent oxygen barrier.

The barrier properties are closely related to the mass transfer properties of the polymers, including the permeation, diffusion, and solubility of various gas and water molecules in the polymers. Therefore, strategies that have been used to improve the barrier include decreasing the absorption, solubility, diffusion, and desorption of the permeant in polymers. Surface coating is a widely used technology to decrease the absorption and desorption of the oxygen or water molecules. Other strategies, such as increasing the crystallinity (decreases the solubility as well as the diffusion rate) and increasing chain orientation (decreases the diffusion rate of the permeant vertical to the chain direction) are also reported to improve the barrier of the polymers. Other methods like incorporating in situ nanofibrils of polybutylene succinate (PBS) or polybutylene adipate terephthalate (PBAT) into poly(lactic acid) (PLA) are also found to increase the barrier of polymers, through creating a “nano-barrier wall” to decrease the diffusion rate of the oxygen gas. Oxidizable compounds have also been tested for improving the oxygen barrier properties. However, the use of some of the oxygen scavengers have challenges, including concerns over stability under high melt processing conditions, migration of the oxidation products, and sometimes unpleasant taste. A filler system is an attractive solution to increase barrier properties of polymers, for its economics, ease of processing, and high efficiency. Fillers like talc, nano-clay, mica, graphene and graphene oxide, cellulose nanocrystal, halloysite, and chitosan, have been used in biopolymers to improve their barrier properties. Generally, it is desirable to treat the fillers, to facilitate separation of the agglomerates of platelet

particles to individual particles, to maximize the barrier performances. However, such treatment is normally costly, in addition to the high cost of some fillers like graphene and graphene oxide.

Comparatively, biocarbon is an inexpensive filler. Using biocarbon to improve the barrier of polymers was first reported by the Mohanty and Misra research team. To protect the invention, patents were filed first, ahead of publication in scientific literature.

Related Patents:

1) Compostable Oxygen Barrier
   Authors: Mohanty, A.K., Wu, F., Misra, M., & Pal, A.
   Publication #: Provisional Patent Ser. No. 63/025,607 (Filed: May 15, 2020).
2) Biodegradable nanostructured composites
   Authors: Mohanty, A.K., Wu, F., & Misra, M.
   Publication #: WO2019113713A1 (Issued: June 20, 2019)
3) Biodegradable polymeric nanocomposite compositions particularly for packaging
   Authors: Mohanty, A.K., Parulekar, Y., Chidambarakumar, M., Kositruangchai, N., & Harte, B.R.
   Publication #: US7619025B2 (Granted: Nov. 17, 2009), WO2007022080A3 (Issued: Nov. 15, 2007).

Related Publications:

1) Pal, A.K., Wu, F., Misra, M., & Mohanty, A.K. (2020) Reactive Extrusion of Sustainable PHBV/PBAT-based Nanocomposite Films with Organically Modified Nanoclay for Packaging Applications: Compression Moulding vs. Cast Film Extrusion. *Composites Part B - Engineering, 108141*.
2) Wu, F., Misra, M., & Mohanty, A. K. (2019). "Rheological monitoring of chemical gelation of biodegradable poly(butylene succinate): importance of peroxide concentration and temperature in reactive extrusion". *ACS Applied Polymer Materials,1,6,1604-1612*
3) Wu, F., Misra, M., and Mohanty, A.K. (2019) "Novel Tunable Super-Tough Material from Biodegradable Polymer Blends: Nano-structuring through Reactive Extrusion". *RSC Advances*, 9, 2836-2847.
4) Wu, F., Misra, M., and Mohanty, A.K. (2019). "Super Toughened Poly (Lactic Acid) (PLA)-based Reactive Ternary Blends via Enhancing Interfacial Compatibility". *ACS Omega* 4 (1), 1955 –1968.
5) Mashouf Roudsari, G., Mohanty, A. K., & Misra, M. (2017). "Exploring the effect of poly (propylene carbonate) polyol in biobased epoxy interpenetrating network". *ACS Omega.2*(2),611-617.
6) Parulekar, Y., & Mohanty, A. K. (2007). "Extruded biodegradable cast films from polyhydroxyalkanoate and thermoplastic starch blends: fabrication and characterization". *Macromolecular materials and engineering, 292*(12), 1218-1228.
7) Parulekar, Y., Mohanty, A. K., & Imam, S. H. (2007). "Biodegradable nanocomposites from toughened polyhydroxybutyrate and titanate-modified montmorillonite clay". *Journal of nanoscience and nanotechnology, 7*(10), 3580-3589.

8) Parulekar, Y., & Mohanty, A. K. (2005). "Effect of titanate-based surface on hydrophilicity and interlayer spacing of montmorillonite clay for polymer nanocomposites". *Journal of nanoscience and nanotechnology, 5*(12), 2138-2143.

2. BIOCARBON IN DURABLE THERMOPLASTIC COMPOSITES

Description:

Mohanty and Misra were first to report that bicarbon is an effective reinforcing agent, filler, and colourant in thermoplastic composites.

Biocarbon is generally defined as the solid carbon-rich residue obtained from the thermal decomposition of biomass through pyrolysis at temperatures greater than 400°C in the absence of oxygen. The biocarbon produced in this way has high porosity and relative surface area. Biocarbon has been used in soil amendment, conductivity, supercapacitor, and adsorbent for various wastewater treatments.

They have made biocabon with the idea to explore ways to increase the renewable content in plastic resins. They have developed high-quality biocarbon from a variety of non-food biomass sources, including nut shell wastes (almond, peanut, and other tree nuts); post-industrial wastes such as coffee chaff; agri-residues (wheat straw, corn stover, soy stalks) and energy grasses (switch grass, Miscanthus, etc.); wood-derived wastes; biofuel co-products like distillers dried grains with solubles (DDGS) and lignin, etc. Their results, supported abundantly by scientific research, show that different sources of biomass can lead to the production of biocarbon with different morphologies and different chemical and physical properties. The overall results show that the morphology and allotropy of renewable biocarbon can be manipulated for materials design.

Mohanty and Misra were the first worldwide to use biocarbon in thermoplastic composites and demonstrate its high potential in industrial applications, to be used as a reinforcement in polymer composite materials and to substitute carbon black, mineral fillers like talc, and short glass fibre. Carbon black (petroleum-based) is widely used today as a reinforcing filler and pigment, used mainly in the rubber, plastics, paint, and ink industries. It is used in almost every black-coloured product around us.

For the full commercial advantage, biocarbon had to be reliably sourced and produced in a range of technical grades. In developing commercially viable supplies of biocarbon, their team faced many challenges in sourcing the right feedstock and defining the material processing parameters needed to meet the technical specifications. Biocarbon has now attracted increased interest for use in biocomposite material applications, due to its beneficial properties and sustainability.

The automotive industry is interested in their formulations, with Ford Motor Company, Volkswagen, General Motors, and Tesla conducting trials of automotive parts created using their new biocarbon-based plastic biocomposites.

First automotive part in commercial application, that was made with their biocarbon formulation, was for the Ford Lincoln Continental model (announced December 4, 2019). The biocarbon in this part is made from the waste coffee chaff, from McDonald's facilities. In addition to meeting the performance standards, the part is about 20% lighter and performs better in injection moulding, resulting in energy savings of 25% during processing. The close collaboration of Mohanty and Misra with Competitive Green Technologies - that licensed this technology, and Ford has been essential to effectively adapt the technology.

The future of biocarbon composites is also with engineering thermoplastics (nylon, PPA and PPS) that will open new avenues of discovery in biocarbon research and manufacturing technologies for structural biocomposites. Their current research has shown that highly-graphitic biocarbons can reduce the thermal expansion of plastics, without losing affinity for the matrix. Therefore, graphitic biocarbon has huge potential to be used in biocomposite materials as an effective reinforcement, providing high mechanical performance and thermal stability. This will open the possibility to use biocomposite materials for high performance applications not possible so far - in applications where metals or thermosets can be replaced: e.g. under the hood in conventional and electric cars (fuel injection systems, coolant systems, water pump impellers, thermostat holder, electric brakes, electronic housings, moulded connectors, switches and relays); engine accessories of Porsche cars; and the leading edge of Airbus aeroplane wings.

Related Patents:

1) Biocarbon and nylon based hybrid carbonaceous biocomposites and methods of Making those and using thereof
   Authors: Mohanty, A.K., Misra, M., Ogunsona, E., Anstey, A., Torres Galvez, S., Codou, A., & Jubinville, D.
   Publication #: US 10,669,420 (Granted: June 2, 2020), CA2973879A1 (Issued: Jan. 19, 2018).
2) Toughened polyolefin and biocarbon based light weight biocomposites and method of making the same
   Authors: Mohanty, A.K., Misra, M., Behazin, E., & Rodriguez-Uribe, A.
   Publication #: US10472440B2 (Granted: Nov. 12, 2019), CA2975803 (Issued: Mar. 2, 2018).
3) Renewable replacements for carbon black in composites and methods of making and using thereof
   Authors: Mohanty, A.K., Misra, M., Bali, A., & Rodriguez-Uribe, A.
   Publication #: US10414880B2 (Granted: Sep. 17, 2019), CA2945688A1 (Issued: Sep. 17, 2015), WO2015135080A1 (Issued: Sep. 17, 2015).
4) Hybrid sustainable composites and methods of making and using thereof
   Authors: Mohanty, A.K., Misra, M., Rodriguez-Uribe, A., & Vivekanadhan, S.
   Publication #: US9809702B2 (Granted: Nov. 7, 2017).
5) Engineering plastic composites with high sustainable content
   Authors: Mohanty, A.K., Misra, M., Jubinville, D., Chang, B.P., Anstey, A., Codou, A., & Abdelwahab, M.

Publication #: PCT/CA2019/051001 (Filed: July 19, 2019).

6) Novel methods for creation of sub-micron biocarbon materials from biomass and their fields of application

Authors: Mohanty, A.K., Misra, M., Vivekanandhan, S., Gonugunta, P., Wang, T., Rodriguez, A., Tiessen, M., & Bali, A.

Publication #: US20190276315A1 (Issued: Sep. 12, 2019), WO2018085918A1 (Issued: May 17, 2018), CA3043249A1 (Issued: May 17, 2018).

Related Peer-reviewed Journal Publications:

1) Watt, E., Abdelwahab, M., Snowdon, M., Mohanty, A.K., Khalil, H., & Misra, M. (2020). "Hybrid biocomposites from polypropylene, sustainable biocarbon and graphene nanoplatelets". *Scientific Reports*, 10(1), 1-13.
2) Codou, A., Misra, M., & Mohanty, A.K. (2019) "Sustainable Biocomposites from Nylon 6 and Polypropylene Blends and Biocarbon - Studies on tailored morphologies and Complex Composite Structures". *Composites Part A*, 105680.
3) Chang, B.P., Misra, M. & Mohanty, A.K. (2019). "Sustainable biocarbon as an alternative of traditional-fillers for poly(butylene terephthalate)-based composites: thermo-oxidative aging and durability". *Journal of Applied Polymer Science*, 47722.
4) Codou, A., Misra, M., & Mohanty, A.K. (2018). "Sustainable biocarbon reinforced nylon 6/ polypropylene compatibilized blends: Effect of particle size and morphology on performance of the biocomposites". *Composites Part A: Applied Science and Manufacturing*, 112, 1-10.
5) Major, I., Pin, J. M., Behazin, E., Rodriguez-Uribe, A., Misra, M., & Mohanty, A.K. (2018). "Graphitization of Miscanthus grass biocarbon enhanced by in situ generated FeCo nanoparticles". *Green Chemistry*, 20(10), 2269-2278.
6) Arnold, S., Rodriguez-Uribe, A., Misra, M., & Mohanty, A.K. (2018). "Slow pyrolysis of bio-oil and studies on chemical and physical properties of the resulting new bio-carbon". *Journal of Cleaner Production*, 172(20), 2748-2758.
7) Behazin, E., Misra, M., & Mohanty, A.K. (2017). "Compatibilization of toughened polypropylene/biocarbon biocomposites: A full factorial design optimization of mechanical properties". *Polymer Testing*, 61, 364-372.
8) Ogunsona, E. O., Misra, M., & Mohanty, A.K. (2017). "Sustainable biocomposites from biobased polyamide 6, 10 and biocarbon from pyrolyzed miscanthus fibers". *Journal of Applied Polymer Science*, 134(4).
9) Nagarajan, V., Mohanty, A.K., & Misra, M. (2016). "Biocomposites with Size-fractionated biocarbon: Influence of the microstructure on macroscopic properties". *ACS Omega*, 1(4), 636-647.
10) Behazin, E., Ogunsona, E., Rodriguez-Uribe, A., Mohanty, A.K., Misra, M., & Anyia, A.O. (2016). "Mechanical, chemical, and physical properties of wood and perennial grass biochars for possible composite application". *BioResources*, 11(1), 1334-1348.
11) Myllytie, P., Misra, M., & Mohanty, A.K. (2015). "Carbonized lignin as sustainable filler in biobased poly (trimethylene terephthalate) polymer for injection molding applications". *ACS Sustainable Chemistry & Engineering*, 4(1), 102-110.

12) Snowdon, M. R., Mohanty, A.K., & Misra, M. (2014). "A study of carbonized lignin as an alternative to carbon black". *ACS Sustainable Chemistry & Engineering*, 2(5), 1257-1263.

3. COMPOSTABLE SINGLE-USE PRODUCTS (INCLUDING COFFEE PODS)

Description:

Professors Mohanty and Misra have a long track record of engineering biocomposite materials to use bio-based plastics in combination with bio-based fillers (including non-food waste residues), creating biodegradable packaging. The use of fillers reduces the amount of plastic used (by up to 30%) and lowers the cost. Importantly, their biocomposites are designed to utilize closed-loop strategies to improve sustainability through the value-added integration of agri-food residues such as wheat straw, corn stover, perennial grasses, and post-industrial residues and wastes such as oat hull, soy meal, canola meal, crude glycerol, and lignin. They have successfully applied this concept in the development of a number or commercial resins, including the world's first 100% compostable coffee pod.

Compostable single-use coffee pods (PurPod100^{TM}) were launched in 2016, by Loblaws, as the world's first 100% compostable coffee pods. The pods are certified compostable for industrial composting, by the Biodegradable Products Institute (BPI) of United States (US). This is truly a successful market story for sustainable packaging, representative of a collaboration that enriched the entire value-chain. The core partnership has not only addressed the business needs of Club Coffee, one of Canada's leading private brand coffee roasters and distributor of packaged coffees, but has also entailed close relationships with Competitive Green Technologies, Fourmark, an injection moulding company, and Loblaws – which was the first major retailer to carry and promote the product.

Designed in their laboratory, this material invention combines the advantages of biodegradable plastics, green chemistry, reactive extrusion, and process engineering, along with the integration of the industrial 'waste' product of the coffee roasting industry. The most challenging component was the pod's structural ring. The main obstacles were price and performance competitiveness of the material. Both were successfully addressed. Their key idea was to use "waste" from reclaimed coffee bean skins with more expensive compostable plastic blends. Over 400 material formulations were tested to reach the commercial specifications for the product. It took less than 18 months from the idea to full-blown commercialization of this invention.

The ultimate success of the innovation was demonstrated by the wide adoption by coffee brand names and distribution in Loblaws stores under the President's Choice brand, Hills Bros brand of Massimo Zanetti Beverages (MZB), KraftHeinz (Maxwell House, Nabob, Ethical Bean), Melitta, Trader Joe's and other brand owners and retailers across Canada and the US, currently in over 80 brands. The benefit of the compostable pods was the reason that drove Ontario-based Muskoka Roastery Coffee, an environmentally conscious company, to offer their product line in the single-serve pod option.

The impact of this product was recognized by awards to the U of G research team led by Prof. Mohanty and Prof. Misra and to the industry partner. The research team received the *U of G Innovation of the Year Award* in 2016. The partnership with the private companies, has led to one of the most significant recognitions in Canada - the 2018 NSERC Synergy Award for Innovation for collaboration with two or more industrial partners. Industry partner Club Coffee received 11 industry awards, including *The Plastics Industry Trade Association's (SPI) 2016 Innovation in Bioplastics Award – the International Innovation Award* and *Bio-Based Product of the Year (Americas) Award*, for providing a compostable solution to millions of consumers.

Related Patents:

1) Biodegradable polymer-based biocomposites with Tailored Properties and Method of Making Those
   Authors: Mohanty, A.K., Misra, M., Zarrinbakhsh, N., Wang, T., Muthuraj, R., Rodriguez-Uribe, A., & Vivekanandhan, S.
   Publication #: WO2016138593A1 (Issued: Sep. 9, 2016), US20180127554A1 (Issued: May 10, 2018), CA2978629A1 (Issued: Sep. 9, 2016), MX2017011379A (Feb. 19, 2018), EP3265515A4 (Issued: Oct 17, 2018).
2) Compositions of Cellulose Esters and Layered Silicates and Process for the Preparation Thereof
   Authors: Mohanty, A.K., Drzal, L.T., Park, H., Misra, M., & Wibowo, A.C.
   Publication #: US7253221B2 (Granted: Aug 7, 2007), WO2005111184A3 (Issued: Oct. 5, 2006).
3) Cellulosic Biomass Soy Flour Based Biocomposites and Process for Manufacturing Thereof
   Authors: Drzal, L.T., Mohanty, A.K., Liu, W.,Thayer, K., & Misra, M.
   Publication #: US7576147B2 (Granted: Aug. 18, 2009).

Related Peer-reviewed Journal Publications:

1) Meereboer, K., Pal, A., Cisneros-Lopez, E., Misra, M., & Mohanty, A.K. (2020). "The Effect of Natural Fillers on the Marine Biodegradation Behaviour of Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV)". *Scientific Reports*, (Accepted: October 2020; In-Press: January 2021).
2) Wu, F., Misra, M., & Mohanty, A.K. (2020). "Sustainable Green Composites from Biodegradable Plastics Blend and Natural Fibre with Balanced Performance: Synergy of Nano-structured Blend and Reactive Extrusion". *Composites Science and Technology*, 200, 108369.
3) Smith, M., MP, D., Abdelwahab, M., Mielewski, D., Misra, M., & Mohanty, A.K. (2020). Sustainable composites from poly(3-hydroxybutyrate) (PHB) bioplastic and agave natural fibre. *RSC Green Chemistry*, 22, 3906-3916.
4) Zytner, P., Wu, F., Misra, M, & Mohanty, A.K (2020). "Toughening of Biodegradable Poly(3-hydroxybutyrate-co-3-hydroxyvalerate)/ Poly(ε-caprolactone) Blends by insitu Reactive Compatibilization". *ACS Omega*, 5, 25, 14900–14910.

5) Wu, F., Misra, M., & Mohanty, A. K. (2020). "Tailoring the toughness of sustainable polymer blends from biodegradable plastics via morphology transition observed by atomic force microscopy". *Polymer Degradation and Stability*, 109066.
6) Muthuraj, R., Misra, M. and Mohanty, A. K. (2017), "Biodegradable biocomposites from poly(butylene adipate-*co*-terephthalate) and miscanthus: Preparation, compatibilization, and performance evaluation". *Journal of Applied Polymer Science*, 45448.
7) Muthuraj, R., Misra, M., & Mohanty, A. K. (2017). "Biocomposite consisting of miscanthus fiber and biodegradable binary blend matrix: compatibilization and performance evaluation". *RSC Advances*, *7*(44), 27538-27548.
8) Muthuraj, R., Misra, M., & Mohanty, A. K. (2015). "Injection molded sustainable biocomposites from poly (butylene succinate) bioplastic and perennial grass". *ACS Sustainable Chemistry & Engineering, 3*(11), 2767-2776.
9) Nagarajan, V., Mohanty, A. K., & Misra, M. (2013). "Sustainable green composites: Value addition to agricultural residues and perennial grasses". *ACS Sustainable Chemistry & Engineering, 1*(3), 325-333.
10) Nagarajan, V., Misra, M., & Mohanty, A. K. (2013). "New engineered biocomposites from poly (3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV)/poly (butylene adipate-co-terephthalate) (PBAT) blends and switchgrass: Fabrication and performance evaluation". *Industrial Crops and Products, 42*, 461-468.
11) Pradhan, R., Reddy, M., Diebel, W., Erickson, L., Misra, M., & Mohanty, A. (2010). "Comparative compostability and biodegradation studies of various components of green composites and their blends in simulated aerobic composting bioreactor". *International Journal of Plastics Technology, 14*(1), 45-50.
12) Huda, M. S., Drzal, L. T., Mohanty, A. K., & Misra, M. (2008). "Effect of fiber surface-treatments on the properties of laminated biocomposites from poly (lactic acid)(PLA) and kenaf fibers". *Composites Science and Technology,68*(2), 424-432.
13) Wibowo, A.C., Misra, M., Park, H.M., Drzal, L.T., Schalek, R., & Mohanty, A K. (2006). "Biodegradable nanocomposites from cellulose acetate: mechanical, morphological, and thermal properties". *Composites Part A: Applied Science and Manufacturing, 37*(9), 1428-1433.
14) Huda, M.S., Drzal, L.T., Misra, M., Mohanty, A.K., Williams, K., & Mielewski, D.F. (2005). "A study on biocomposites from recycled newspaper fiber and poly (lactic acid)". *Industrial & engineering chemistry research,44*(15), 5593-5601.
15) Park, H.M., Misra, M., Drzal, L.T., & Mohanty, A.K. (2004). ""Green" nanocomposites from cellulose acetate bioplastic and clay: effect of eco-friendly triethyl citrate plasticizer". *Biomacromolecules, 5*(6), 2281-2288.

4. DURABLE (NON-BIODEGRADABLE) BIOCOMPOSITE MATERIAL FORMULATIONS – (INCLUDING BIOBINS AND FLOWERPOTS)

Description:

The BioBin and Bio-based Flowerpots are two commercial products that use composites of biofibres and recycled plastics. The biocomposite material formulations were designed and made with a range of natural fibres and post-consumer plastics, providing a lower carbon footprint, at a

low price. “Biofiber reinforced recycled composite resins” technology, developed by Professors Mohanty and Misra, reduces the amount of plastic used by around 25% with significant environmental benefits. The commercial BioBin and Bio-based flowerpots were launched in 2011 and 2014, respectively. BioBins were launched in two major Canadian retailers – Home Hardware and Canadian Tire. The Bio-based Flowerpots were sold in Lowe’s and Home Hardware in Canada and Kroger in USA.

Related Patents:

1) Biofibre reinforced recycled composite resins (Formulations kept as trade secret in 2010)
   Authors: Mohanty, A.K., Sahoo, S., Reddy, M.M., Ahankari, S., Nanda, M., & Reddy, J.
   Licensed to: Competitive Green Technologies.

Related Peer-reviewed Journal Publications:

1) Chowdhury, I.H., Abdelwahab, M.A., Misra, M., & Mohanty, A.K. (2021). “Sustainable Biocomposites from Recycled Bale Wrap Plastic and Agave Fiber: Processing and Properties Evaluation”. *ACS Omega*, (Accepted: December 2020; In-Press: January 2021).
2) Watt, E., Abdelwahab, M., Snowdon, M., Mohanty, A.K., Khalil, H., & Misra, M. (2020). "Hybrid biocomposites from polypropylene, sustainable biocarbon and graphene nanoplatelets". *Scientific Reports*, 10(1), 1-13.
3) Balint, T., Chang, B.P., Mohanty, A.K., Misra, M. (2020). “Underutilized agricultural co-product as a sustainable biofiller for polyamide 6,6: Effect of carbonization temperature”. *Molecules,* 25(6), 1455.
4) Abdelwahab, M.,Rodriguez-Uribe, A., Misra, M., Mohanty, A.K. (2019). “Injection molded novel biocomposites from polypropylene and sustainable biocarbon”. *Molecules*, 24, 22, 4026.
5) Zarrinbakhsh, N., Mohanty, A.K., and Misra, M. (2019). “Formulation optimization of bioreinforced composites from polyolefins and dried distillers' grains using statistical methods”. *Composites Part A*, 119, 246-260.
6) Nanda, M. R., Misra, M., & Mohanty, A. K. (2012). “Mechanical performance of soy-hull-reinforced bioplastic green composites: a comparison with polypropylene composites”. *Macromolecular Materials and Engineering*,*297*(2), 184-194.
7) Zampaloni, M., Pourboghrat, F., Yankovich, S.A., Rodgers, B.N., Moore, J., Drzal, L.T., Mohanty, A.K., & Misra, M. (2007). “Kenaf natural fiber reinforced polypropylene composites: a discussion on manufacturing problems and solutions”. *Composites Part A: Applied Science and Manufacturing, 38*(6), 1569-1580.

5. “GREEN FLOOR”

Description:

Prof. Mohanty and Prof. Misra developed a “green floor” formulation while at Michigan State University. His innovation eliminated plasticizers containing harmful phthalates. The formulation is based on a plant derived plastic resin, poly(lactic acid) (PLA) and provides a successful substitute for common poly(vinyl chloride) (PVC) flooring. The innovation has been

licenced to Armstrong World Industries Licencing LLC, in Delaware and has been commercialized in the USA – it is marketed by AWI Flooring company.

Related Patents:

1) Floor Covering Made from an Environmentally Friendly Polylactide-Based Composite Formulation
   Authors: Mohanty, A.K., Drzal, L.T., Rook, B.P., & Misra, M.
   Publication #: US7354656B2 (Granted: Apr. 8, 2008).
2) Environmentally Friendly PolyLactide-Based Composite Formulations
   Authors: Mohanty, A.K., Drzal, L.T., Rook, B.P., & Misra, M.
   Publication #: US7256223B2 (Granted: Aug. 14, 2007), DE60307536T2 (Granted: Aug. 9, 2007), EP1361039B1 (Granted: Aug. 16, 2006), AT336357T (Granted: Sep. 15, 2006), DK1361039T3 (Granted: Dec. 27, 2006), PL360048A1 (Granted: Nov. 17, 2003), CA2427012C (Granted: Apr. 3, 2012), US6869985B2 (Granted: Nov. 26, 2002).

Related Peer-Reviewed Journal Publications:

1) Nagarajan, V., Mohanty, A. K., & Misra, M. (2018). "Blends of polylactic acid with thermoplastic copolyester elastomer: effect of functionalized terpolymer type on reactive toughening". *Polymer Engineering & Science*, *58*(3), 280-290.
2) Nagarajan, V., Zhang, K., Misra, M., & Mohanty, A. K. (2015). "Overcoming the fundamental challenges in improving the impact strength and crystallinity of PLA biocomposites: influence of nucleating agent and mold temperature". *ACS applied materials & interfaces*, *7*(21), 11203-11214.
3) Zhang, K., Nagarajan, V., Misra, M., & Mohanty, A. K. (2014). Supertoughened renewable PLA reactive multiphase blends system: phase morphology and performance. *ACS applied materials & interfaces*, *6*(15), 12436-12448.
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