Center for Bioplastics and Biocomposites (CB²) – Call for Proposals
2020 Projects
Released 7/3/19, 2-page proposals due 8/7/2019

Guidelines for Participation as an Investigator
The National Science Foundation Industry & University Cooperative Research Center program is a vehicle for encouraging formal, topical relationships between academic institutions and industry collaborators. Research projects that make a good fit to the program and to the CB²:

- Address any of the request-for-proposal topics from the IAB (Industry Advisory Board) “seed concepts” (attached). Also attached are the TWO LIFE forms that detail the general interest in the seed concepts from the IAB
- Aim to solve an applied problem on an aspect of the bioplastics or biocomposites supply chain. Review CB²’s research thrust areas online.
- May be of particular interest to one industry partner, but preferably of broader significance.
- Build off collaborative projects you have had with potential members in the past.
- Highlight the unique capabilities and expertise of affiliated faculty.
- Offer precompetitive, but compelling solutions to difficulties the industry must overcome to advance.

Please note that the authors of the seed concepts are identified and PIs are highly encouraged to work with them in order to strengthen proposal development process.

A select number of projects will be selected for podium presentations at the fall planning meeting to be held November 5-6, 2019, the location is tentatively Diageo, Plainfield, IL. Faculty members can submit an unlimited number of project synopses for project concepts. The format is an executive summary as per available on the center’s web site. The IAB will narrow the field to the most compelling projects from an industry standpoint. The CB² call for proposals is open to all faculty members at the CB² university sites. Collaborative projects with multiple faculty members and across campuses are encouraged. The PI’s are required to attend the six month and 12 month review meetings as well as submit progress reports at three and nine month periods into the research and have monthly conference calls with their selected mentors from the IAB.

Submission Instructions
To submit a proposal for the CB² Fall 2019 meeting, please complete the “Application form” upload to the link by August 7, 2019 (midnight local time, https://ndstate.co1.qualtrics.com/jfe/form/SV_40cw2LUCWZuavEV (NOTE an updated link may come under separate cover). The proposals will go through an initial ranking by the IAB to allow PIs to strengthen their proposals for a second submission. The initial rankings will be completed approximately September 13. A decision on which proposals will be selected for a presentation at the fall meeting will be announced on September 20, 2019.

Funding per project should range from $40,000 to $60,000 of direct cost per year with a typical project duration of one year. Projects requiring more than one year of funding must submit new proposals for additional years. The original proposal may indicate that additional years are planned, but should only detail year one. Allowable costs include, but are not limited to the following: tuition, stipend, faculty salary, undergraduate salary, benefits, travel (international and domestic and should include one to two trips to the IAB meeting), materials, laboratory fees, and equipment. Please note, there are no indirect costs allowed in the project budgets. In addition, the budget should include $500 for REU travel. All funded projects will be assigned an REU during the summer 2020 where applicable.
SEED CONCEPTS
For 2020 Projects
SC 1 Benjamin Maloy, Evolve Golf
100% Biobased Zero VOC Clear Varnish for Wood Products. The project aim is to develop a replacement for petroleum based high VOC clear varnishes for wood products with a zero VOC biobased varnish. Applications would include small turned wood products, flooring substrates, and furniture that are typically coated with polyurethane varnishes. Home owners and builders are increasingly seeking eco friendly options for their building projects. Brand owners are looking to decrease their environmental impact and increase the marketing appeal of existing product lines by appealing to socially responsibly buyers. Thrust areas include synthesis and compounding, biobased products, and processing.

SC 2 Benjamin Maloy, Evolve Golf
Rigid and Tough Post Consumer Polypropylene Compounded with Natural Fibers and Biobased Resins for Injection Molding Applications. The project aim is to develop a low cost, lightweight, rigid and tough post consumer recycled polypropylene and biobased composite that is easy to process in injection molding applications. Brand owners are seeking to reduce product costs, lightweight parts, and decrease environmental impact while appealing to socially responsible consumers. Applications are wide ranging from consumable consumer goods to automotive parts for hybrid and electric car applications. Thrust areas include synthesis and compounding, biobased products, and processing.

SC 3 Author: Martin Cockroft & Kelly Williams
Affiliate: Futamura
Title: “Understanding the structural requirements of compostable polymers”

Key Words/Themes: “Fundamental Study”

Seed concept:
Plastic will continue to play an important part in the global economy and distribution chain. Recycling will become a critical part of controlling the environmental impact of plastic. It is also clear that in many scenarios, materials are required that will disappear in a reasonable time if they are released into the environment. It is therefore critical to understand how materials compost, and to drive the development of new polymeric materials to replace traditional plastics.

A range of base polymer resins could be selected, and the exact molecular structure defined. Industrial and/or home composting biodegradation phenomena of the selected polymers can be tested through the study of the specific consortia of microorganisms before, during, and after material inclusion. This would create an initial assessment of material behaviours under composting conditions linked to microorganism assays.

Studying these results, a link may be established between structure and composting rates, from which novel or modified polymer structures could be proposed, synthesised and tested for composability, or the identification of potential microorganisms that thrive in certain material environments.

This would create a library of the composting rates for a range of base polymer types, providing valuable information for all member companies who undoubtedly use a wide range of polymers, be it in packaging, composites, processing, or otherwise.
Furthermore, this could create the foundations for scientifically modelling new polymeric structures to develop a wider range of compostable base polymers from which to develop new materials for packaging and component parts. Specific interest could also come from selecting starting monomers from industrial waste streams. For instance, using Lignin, xylan, xyloglucans and mannans from the wood pulping and pulp and paper-processing based industries.

**Seed concept:**
Surface coatings are a traditional way of adding additional functionality to a wide range of materials, especially in paper making, wood-based products, component parts and a wide range of packaging materials. As the global awareness of the impact of plastic waste grows, and more legislation is developed to mitigate this, then there is a need to develop materials to replace the non-compostable counterparts. Surface coatings, if made compostable, could be used to compliment the limited range of compostable materials, to help produce a wider range of plastic alternatives, whilst not compromising on functionality. This is specifically of interest in the packaging market where surface printing with over-print varnishes is underway to replace the more wasteful and unnecessary method of reverse-image printing on a clear film followed by adhesive lamination. The idea here would be to develop novel, water-based or energy-curable, compostable coating materials that can be used to add functionality to other materials, such as thin films used in packaging, paper, wood and/or plant-based products, and solid component parts. It is also possible that these new polymers could be used as a platform for future adhesive formulations as well as other waterborne systems.

Functionalities of interest could include, but are not limited to:

- Heat seal-ability
  - From simple tack seals to hermetic seals
- Barrier to water vapour and oxygen
- Print receptivity
- UV Barrier
- Optical/Aesthetic effects (soft touch, matte, colour shift etc)
- Surface protection (over print varnish etc)
- Securitisation
- Re-closable seals
- Pressure sensitive adhesive

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**SC 5 Author: Dr. Silapong Baiagern, Dr. Kanjanee Nawamawat, Dr. Parkpoom Loijai**
**Affiliate: PTT Global Chemical**
**Title: Bioplastic (PLA, PBS) compounds for Thin Wall application**
Seed concept:
Key Area: Synthesis and compounding

Overview
Thin wall injection molding is a specialized form of conventional injection molding that focuses on mass-producing plastic parts that are thin and light, without structural compromise, so that material cost savings can be made and cycle times can be as short as possible. Faster cycle times mean higher productivity and lead to lower costs per part. The definition of thin wall is really about the size of the part compared to its wall thickness. For any particular plastic part, as the wall thickness is reduced, the harder it is to manufacture using the injection molding process. The size of a part puts a limit on how thin the wall thickness can be. For packaging containers, thin wall means wall thicknesses that are less than 0.025 inch (0.62mm) with a flow length to wall thickness ratio greater than 200\(^{[1]}\). The trend towards thin wall molding continues to increase in many plastic industries as plastic material and energy costs continue to rise and delivery lead times are squeezed. However, thin wall packaging is usually a single-use packaging which encounters the difficulty in recycling; consequently, generating the plastic waste which leads to the environmental concern.

Needs
Bioplastic (PLA, PBS) which can be compostable is one of the candidate solutions to overcome the current worldwide issue of plastic waste. The development of bioplastic compound to serve the requirements of thin wall applications in terms of material properties, cycle time & processability, heat and barrier resistant, and multilayer structure material will potentially innovate materials for the future. To enable bioplastic (PLA, PBS) suitable for thin wall applications, one which provides a very high melt flow rate is required. Moreover, the properties of high heat resistance to withstand the thin wall injection molding process, fast crystallization rate and easy mold release are also necessary to help improve cycle time and increase productivity.


SC 6 Author: Mr. Viboon Pungprasert
Affiliate: PTT Global Chemical
Title: Bioplastic compounds (PLA, PBS) for stretch wrap or stretch film application

Seed concept:
Key Area: Synthesis and compounding

Needs
Polymer additive / Compounding recipe/ Technology that would enable bioplastic PLA, PBS to be processed and used as stretch wrap film for industrial applications i.e. pallet stretch wrap. The invention should serve the requirements of stretch wrap/film applications in the following areas
  
  o Processability
  o Mechanical property

SC 7 Author: Miss Patima Wongmanit
Affiliate: PTT Global Chemical
Title: Biodegradable polyolefins

Seed concept:
Key Area: Synthesis and compounding

Overview
The demand for packaging is increasingly growing thanks to urbanization. Packaging waste forms a significant part of solid waste and has caused increasing environmental impact. Among a wide range of petroleum-based polymers that are currently used in packaging, polyolefins is a big portion that creates a non-recyclable waste.

**Needs**

Compounding recipe/ Technology that would enable polyolefins to become biodegradable. The invention should serve the requirements in the following areas

- Biological processes/ enzyme-based biotechnology
- More than 90% degrade in 12 months

**SC 8 Author: Jim Preston**
**Affiliate: RheTech**
**Title:** Reduce fogging characteristics of natural fibers
**Seed concept:** The automotive companies all have fogging requirements where any plastic compound used cannot outgas and cause a fog or buildup on glass or plastic lens. This is limiting where we can position our plastic compounds within the automobile. Can a method or additive be developed to minimize or prevent natural fiber filled compounds from outgassing after molding.

This research would interest Ford & Hyundai as well

**SC 9 Author: Jim Preston**
**Affiliate: RheTech**
**Title:** UV Stabilization of Natural Fibers
**Seed concept:** We have proven we can UV stabilize plastic and protect from UV degradation. When we incorporate natural fibers into polypropylene they will gray over time. This graying is limiting applications we can supply into because the OEM wants the plastic and the natural fibers to remain unchanged over time and with sun exposure. Is there a method available to protect the natural fibers from UV that does not greatly impact the cost of the compound?

**SC 10 Author: Kellie Ballew**
**Affiliate: Shaw Industries Inc.**
**Title:** Biobased Polymer for Fiber
**Seed concept:** Research and develop a biobased polymer that can be extruded commercially into a fiber for use in textile applications. The resultant fiber would need to be performance and cost competitive with existing fiber systems such as nylon 6, nylon 6,6 or polyester. In order to scale into manufacturing, biobased polymers would ideally process on existing manufacturing equipment for fiber extrusion & fabric assembly.

Potential sectors & commercial uses could include vehicle airbags, commercial wallcovering, acoustical panels, carpets, apparel & clothing, seat belts, commercial furniture fabrics, window shades, etc. There are market demands for low embodied carbon and carbon neutral products where biobased polymers could be a technological fit. VOC emissions & toxicology profile of the biopolymer need to meet or exceed existing synthetic fiber results. Lastly, a biobased
polymer for fiber applications could have enhanced value if recyclable or able to be depolymerized for reuse.

**Key Thrust Area:** Biobased products, Processing, Synthesis & Compounding

**SC 11 Author: Kellie Ballew**  
**Affiliate: Shaw Industries Inc.**  
**Title:** Biobased Polymer to Replace PVC  
**Seed concept:** Develop a biobased polymer that can be used to replace polyvinylchloride (PVC) in building materials. Ideally this polymer would be non-halogenated and be capable of being plasticized. The resultant polymer would need to be performance and cost competitive with existing products such as flooring, piping, wire and cable sheathing, door & window construction, window cloth, wallcovering, etc. PVC is a highly scrutinized polymer in the commercial built environment and several customers and product certifications are restrictive on its use. Additionally, market demands for low (or zero) embodied carbon products are causing industry to utilize sources of post-consumer recycled content that contains legacy chemicals of concern that have historically been used in PVC-based products such as ortho-phthalates and heavy-metal stabilizers. A biobased polymer that can be used on existing manufacturing processing equipment, with similar performance characteristics and cost could revolutionize the commercial built environment. Bio-derived polymers with a lower carbon footprint and lower toxicity concern and could be a technological innovation. Lastly, a biobased polymer to replace PVC could provide a solution to end-of-life fate and support circular economy principles.

**Key Thrust Area:** Biobased products, Processing, Synthesis & Compounding

**SC 12 Author: Kellie Ballew**  
**Affiliate: Shaw Industries Inc.**  
**Title:** Biobased Adhesive System  
**Seed concept:** Develop a biobased adhesive system that can be used with building materials to bond substrates together replacing existing acrylic, polyurethane, SBR, etc systems. Ideally this polymer would capable of being used with multiple materials and hold up to environmental conditions such as temperature, moisture, and pH. The resultant polymer would need to be performance and cost competitive with existing products. There are market demands for low embodied carbon and carbon neutral products where biobased polymers could be a technological fit.

**Key Thrust Area:** Biobased products

**SC 13 Author: Erik Hagberg**  
**Affiliate: ADM**  
**Title:** PEF Blends for packaging and durable goods (SC-006(R))
Seed Concept: With the commercialization of PEF and PTF rapidly approaching by various parties, there are a number of opportunities and challenges to develop new blend compositions to take advantage of unique properties afforded by these materials. Most effort to date on application development of these materials has focused on beverage packaging and the substantial improvement in barrier properties compared to PET. Additional beneficial properties deriving from blending and compounded these materials with other engineering thermoplastics remains substantially unexplored. The furanic backbone would be expected to enable a number of new miscible and compatible blends compared to current polyester offerings bringing about possibilities to combine the outstanding barrier properties, high heat distortion temperatures and greater modulus of PEF with attributes of common engineering thermoplastics. Expected outcomes would be information on physical properties, processing, molding, and recycling as foundational knowledge for application development by member companies.

SC 14 Author: Erik Hagberg
Affiliate: ADM
Title: Polyamides derived from ozonolysis of oleic acid or difunctional diacid mixtures.
Seed Concept: Nylon 6,9 or Nylon 6,8 have the potential to be very interesting materials. These materials have not been widely studied, but it should be expected that they would provide mechanical properties similar to that of nylon 6,6 while absorbing significantly less water than nylon 6,6. The ozonolysis of oleic acid provides one equivalent of azelaic acid and one equivalent of nonanoic acid. Alternatively, a diacid (C16:1 or C18:1), would provide two equivalents of the diacid to utilize in the production of Nylon, vastly improving the atom efficiencies. There are sources of either C16:1 diester/diacid, C18:1 diester/diacids or the w-OH acid/ester form of these 16 or 18 carbon chains that could be oxidized to a diacid and then undergo ozonolysis to provide C8 and C9 diacids. This would allow us to study the role of carbon length on the performance of the materials. Anticipated outcomes would be development of a highly bioderived nylon and a better understanding of the thermal and mechanical properties of Nylon 6,8 and Nylon 6,9.

SC 15 Author: Erik Hagberg
Affiliate: ADM
Title: Biodegradable Polycondensation Elastomers Derived from Glycerol and Levulinic Acid
Seed Concept: Glycerol and levulinic acid are both biologically derived molecules that are easily accessible as feedstocks, making them attractive building blocks for polymers. When glycerol and levulinic acid react together they make a traditional AB monomer (carboxylic acid-alcohol) for performing polycondensation polymerization. While there are a few examples in literature of this material in its oligomeric form, there is an extreme lack of data regarding the mechanical and thermal properties of reasonable molecular weights (10kDa or higher). These materials would be expected to have a relatively low glass transition temperature and tend to behave like elastomers. Additionally, the ketal linkage is one that could be exploited relatively simply to provide biodegradability. This in combination with the biologically derived sources would allow for a material that is both biorenewable as well as biodegradable. Projected deliverables from this project would be characterization of high molecular weight glycerol levulinic polymers as
well as some initial work in producing and characterizing block copolymers with other condensation polymers (such as PLA).

**SC 16 Author: Erik Hagberg**  
**Affiliate: ADM**  
**Title Bioderived and Biodegradable Polyesters Similar to Polyethylene**  
**Seed Concept:** Polyethylene is a widely used material for a variety of applications; however, it has some major drawbacks. Polyethylene is both not biologically sources as well as non-biodegradable. Polyesters on the other hand, tend to degrade much faster than polyolefins such as polyethylene. Additionally, long chain diacids (such as C16:1 diacids), can be produced using a fermentation process. It is expected that a sufficiently long chain polyester would have properties similar to that of polyethylene, thus providing a polyethylene alternative that is both biorenewable as well as biodegradable. In this project, it would be expected that we could produce and characterize a polyester with similar properties to LDPE using completely biologically sourced monomers as well as analyze the biodegradation of the polyester.

**SC 17**  
**Author: Martin Cockroft, Somayeh Nassiri & Michael Wolcott**  
**Affiliate: Futamura, Assistant & Regents Professors, Washington State University**  
**Title:** Processing waste materials and Nano cellulose to be used in concrete for strength and durability  
**Key Words:** “Valorisation of Waste” “Materials Science”  

**Seed concept:** Within the IAB it is clear most of the member companies will have a number of waste streams in their processes. These materials will range from cellulosic and lingo-cellulosic materials of various purities, biopolymers and plastics as well as agricultural waste materials. As such this concept could potentially benefit many of CB2 member industries, by creating a non-polluting, value stream for off grade material or waste products.

A number of recent studies have demonstrated the remarkable potential of cellulose nanofibers in enhancing many performance attributes of concrete such as strength, cracking resistance and workability. Likewise, research conducted in the UK has shown it is possible to utilize post-consumer plastic waste as a concrete enhancing additive. However, the use of recycled materials from plastic or other waste in concrete remains mainly in research labs failing to transition to real-world construction market due to impediments such as variability in performance and limited improvement in performance. It may be possible to process a range of waste materials from IAB member processes into a form that allows for these materials to be utilized in combination with nano-cellulose materials, to enhance performance and increase chances of success in achieving effective cement products with well-controlled and repeatable properties. This research will build the knowledge base required to facilitate the ability to convert a range of waste materials into concrete enhancing additives and detail the range of properties achievable from different materials and pre-processing steps.
1) key thrust area
   a. Synthesis and compounding
   b. Biobased products

SC 18 Author: Bill Reed, Branson Ultrasonics – Emerson/Branson Ultraonics
Title: Moisture sensitivity of PLA/PBS blends during Ultrasonics welding.
Seed Concept: Determine the effect of moisture content in the ultrasonic weld quality of PLA and PBS materials. PLA (polylactic acid) and PBS (polybutylene succinate), are popular ‘bioplastics’ which are increasingly being used in applications where there is a necessary joining or sealing process. The sealing methods of ultrasonic welding and vibration welding are commonly implemented. Ultrasonic welding is generally preferred due to the quick cycle time and lower equipment cost as compared to vibration welding.

Resin processing and handling techniques along with critical molding parameters and post-mold handling of components, can positively or negatively affect secondary joining methods results. The subject materials have proven to have significant hygroscopic characteristics. But to what extent and at what percentage does moisture absorption in PLA and PBS affect weld quality?

The data that would be generated from this study would be valuable to the users of these emerging materials, the suppliers of assembly equipment and tooling, and to the resin and additive producers.

Key Word: Processing

SC19 Author: Erik Ashby, Jinwen Zhang, Tuan Liu
Affiliate: REG and Washington State University
Title: Glycerol-based UV curable materials for 3D printing of hydrogel
Seed concept: Traditional hydrogel cannot be reshaped or reprocessed after crosslinking. This creates waste during the manufacturing process and at the end of product life. It also limits the applications and capabilities for hydrogel in new products where it would otherwise be beneficial and crosslinking would provide performance benefits.

In this project, glyceryl methacrylates (GMAs) will be synthesized via the reaction of glycerol and methacrylic acid, a mixture containing mono-, di- and tri-methacrylates will be obtained, and the mixture will be polymerized to make a hydrogel that can be crosslinked. The abundant ester bonds and hydroxyl groups in the crosslinked hydrogel structure will exchange via dynamic transesterification at high temperature (> 100 °C), which provides reshaping and reprocessing properties to the hydrogel. The success of the proposed research will broaden the application of hydrogel to be used in 3D printing, and make it possible for hydrogels to be used in new classes of products.

Glycerol is a cost-effective and renewable resource generally produced from hydrolysis and alcoholyis of plant oils and animal fats. The three hydroxyl groups from glycerol can be easily functionalized via
chemical modification, and they also provide unique water solubility to glycerol. By tuning the ratio of glycerol and methacrylic acid, the average functionality of GMA can be manipulated. The polymerization of mono-methacrylate will result in linear polymer, while that of mono-, di- and tri-methacrylates will result in crosslinked polymers. In considering its flexible backbone structure and water solubility, GMA will be used as UV curable ink for the 3D printing of hydrogel. Specifically, GMA aqueous solution with photo initiator will be loaded into a UV 3D printer. The swelling ratio and mechanical properties of the printed hydrogel will be manipulated by tuning the concentration of GMA in water and the average functionality of GMA.

Key words: Synthesizes
1st ROUND OF LIFE FORM OF SEED CONCEPTS
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 1 (University of Georgia) - May 22nd, 2019

New Proposals: Level of Interest

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Project: (SC-001) 100% Biobased Zero VOC Clear Varnish for Wood Products
Phase: New Proposal
Project PI: Benjamin Maloy (Evolve Golf)

Level of Interest
Very Interested - 7
Interested - 12
Interested with Change - 2
Not Interested - 4
Abstain - 4

Very Interested
• How are the coatings applied? Asked and answered already
• Are waterborne coatings possible? Are there parameters for viscosity, application method, curing time needed, property requirement?
• Will be good not just for industrial use, but also as a consumer product for home use.
• There are zero VOC coatings that are energy cured (UV or Electron Beam). 100% biobased solutions are not there yet, but that is an objective of many industry leaders in this arena.
• Would love to see bio-based non-isocyanate polyurethanes included. I'll find you to discuss ideas.
• I believe that Evolve Golf has reasonable goals for a product that merits a truly 100% bio-based and biodegradable product. We currently have two projects that have been in developments for 1-2 years for the purpose of imparting hydrophobicity to lignocelulosic substrates (with paperboard and timber products as target substrates).

In these projects, there are some clear analogues in the application of hydrophobic zero VOC and dispersion technologies.

We would like to discuss more with you about the two natural product coating technologies.

Interested
• The market for such a product is there, this is a solid concept.
• Working to create bio based coatings with hydrophobic functionality is of interest. Clearly this has a wood boast but the learning could be applicable to other areas.
• Like the idea there is a broad impact for several industries/companies
• Good idea with more broad application beyond golf tees although there is huge volume in golf tees.
• What is the current product used commercially?
• Very needed technology for wood coatings to address VOC emission issues as described. Would ask for variable gloss level to appeal to more sectors. Flooring, in particular, has a full range of desirable gloss levels.

• Add the performance requirements to the seed concept.

• 100% Biobased coating is a bit far fetched, but an important.

• Smooth and glossy coatings could be made from a hard and durable material like a formulated PLA or other. Flooring, furniture and building products need to be included in the emphasis to capture a broad enough scope.

Interested with Change

• “Coatings” in general that can be made from materials that have end of life (composting) are a wider need in many industries. This is a piece of a need for a longer term/range potential project. This should be added to the needs for other industries but to separate, perhaps, “biobased” from “Earth Digestible.”

• Would seem to be an opportunity for a neat thermosetting material. Possibly a UV cure or polyurethane. Or epoxy. There have been several epoxy materials explored and proposed in the center, might be worth looking at those concepts again.

Not Interested

• John Deere does not apply coatings onto wood-based materials

• Cool idea. Maybe a blast to the past. Coatings like this not needed in our industry.

• Not relevant to my industry but seems like an important gap that needs to be addressed.
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 1 (University of Georgia) - May 22nd, 2019

Project: (SC-002) Rigid/Tough Post Consumer Polypropylene Compounded w/Natural Fibers & Biobased Resins for Injection
Phase: New Proposal
Project PI: Benjamin Maloy (Evolve Golf)

Level of Interest
Very Interested - 5
Interested - 11
Interested with Change - 2
Not Interested - 6
Abstain - 8

Very Interested

• Capturing the reuse/repurpose of plastics should be a focus the center as it is part of sustainability

• Should be mandated that it should be 100% post consumer PP

• Several fibers may meet the requirements. Look at several other applications.

• A nice, straight forward project.

Interested

• Similar the coatings for wood products, this is an example of a need inside a larger need that, perhaps, should be cast as a larger potential program that maps out logical material/composite pathways that meet other needs in the market. Injection molding as a particular area might be a way to cast a wider net?

• I appreciate this idea, and perhaps look to "ocean plastic" projects (Method bottles comes to mind).

• Great idea to combine plastic reduction (natural filler) with post-consumer resin.

• Interested in knowing the degradation aspect of these blends and also how can the paperbased product can be used. We have some water resistant paperboard which can be looked at as well or as precursor.

• Like the recycled PP component as it gets to less reliance on fossil fuels (particularly for short term) as well as understanding how to process mixtures of resins with natural fiber sources. Learnings should be applicable to resin/fiber mixtures in general for injection molding.

• I like the idea of the â€œbaby stepsâ€• toward using less plastic. Also, knowing the materials properties needed and temperature ranges about which we can design around.

• Interesting project - would be very interesting if wood fiber were included.

• It is a very interesting project. Does the cost of the fiber be critical? It would also be interesting
to conduct the life cycle analysis of the product to assess sustainability.

Interested with Change

- Would be interested if this project quantified variability in post-consumer PP feedstock and how that influences blends with biopolymers and biofillers

- I broadened the concept to: Injection molding recycled PP with biobased fibers and composite materials for small channel high shear processing. Stability, flow of material and useful end use properties are the critical components.

This direction change takes me from not interested to moderate/low interest in this project. There should be a lot of research and options on the market already that are in this category.

Not Interested

- It seems to me that there are many PCR polypropylenes available today. Incorporating natural fibers should not change matters much. I am worried there is not enough in this concept that is novel.

- I understand the concept, but unsure if this is the appropriate forum for that work. I imagine the idea requires compounding experimentation and could be facilitated in many other ways.

- Aren’t there numerous, existing materials in the marketplace that are similar to what is suggested with this seed idea?

  I don’t think this is sufficiently distinct as a new initiative for CB2 efforts & $$. 

- This project will indeed impart less plastic to the final product, but at the expense of making a recyclable polypropylene material into a product that is no longer recyclable and will likely fragment into smaller non-biodegradable plastic particles. The particle micronization process would be accelerated by ultra violet light exposure on the courses. This route does not seem like a good material for courses and tea ranges.

  I predict such a composite would over time deposit polypropylene micro particles into the environment.

  However, using PBS/PHA blends would afford a final composite that would be 100% biodegradable.

Abstain

- We aren’t a polypropylene manufacturer and therefore can’t support.
LIFE Form Review  
CB2: Seed Concepts for 2020 Projects_Round 1 (University of Georgia) - May 22nd, 2019

Project: (SC-003) Understanding the Structural Requirements of Compostable Polymers
Phase: New Proposal
Project PI: Martin Cockroft & Kelly Williams (Futamura)

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**Very Interested**

- Within the energy curable space the primary backbones are urethanes, epoxies, and polyesters that are free radically polymerized using acrylate functionality. Understanding the potential degradation processes that can be designed in those primary backbones will help us design potentially compostable materials, but also have mechanical and physical properties that are suitable for their intended application. This is a great approach as the energy curable process is typically 100% solids and has a lower carbon footprint for manufacture and implementation.

- Excellent idea, this would be a necessary and fundamental study.

- This is a great idea, and very much needed in the packaging industry.

- Interesting idea. However, while understanding what organisms/enzymes will cleave various bonds at a molecular level is important, it will also be important to understand how the bulk material erodes as well and how parameters such as crystallinity, hydrophobicity/hydrophilicity will affect that.

- Important to clarify differences between compostability and biodegradability.

- Yes, fundamental studies related to biodegradation, and developing new microbial consortia and polymers are required.

- I like the project. Understanding the fundamental of compostability is very good topic. It will be key to understand how microorganism interact with different polymers as as new generation of biobased materials.

- this is a foundational project, meaning that it has basic research components. It sounds like folks here have the right idea about reaching out to those who do environmental microbial genome sequencing. These genome data can/and probabaly are already being used to identify the metabolic pathways expressed in the microbial population. This information can then be "cross-referenced" against substrate polymers.

- I'm interested in understanding the breadth of microbial communities that are present across a range of facilities, particularly as a function of time throughout the year. After that characterization I'd like to see how a standard set of materials perform in those communities and with characterization of what the facilities are like (their conditions might vary which will also influence the nature of the communities). All with the goal of figuring out can we set
composting facilities up for success.

- We may talk about this project more and continue the conversation about how the plastic components of multi-layer packaging may or may not biodegrade in controlled composting.

If you would like to know more about this proposed work involving a national survey of the microbes associated with the process of biodegradation, please let UGA New Materials Institute and Futamura group know.

- More information is needed regarding the experimental design of the project to determine the larger scale goals?

What is the source of the compost, and if commercial, do they have prior knowledge of the microbial landscape.

Are you more interested in the microbiology aspect (i.e., identification) or the general correlation between compostibility and molecular structure?

Is there an desire to identify the breakdown products?

**Interested**

- I like the idea of a database of degradability, compostability, and strength change as a function of time and microorganism type. A detailed literature review is a good starting point.

- Yes, composting and biodegradation of all polymers are very important. Degradation media and kinetics are important.

- I can see the value in this type of project, but it would be important to clearly outline the scope in the beginning due to the enormity of this type of study.

- I believe this is going to lean heavily on researchers with expertise outside current schools. It's a good idea, but not sure it fits in CB2 scope logistically? (Certainly fits into scope conceptually.)

- This comes across as a potential multi-institution, long-term project. Several investigators with different, but complementary backgrounds would be needed.

- Interesting concept worth pursuing; good fit for the center. Building a structure/property database of compostibility can help material design with end of use more easily included.

- Is not only helps identify the design criteria needed for the polymer but also helps identify some of the criteria additives need in order to be incorporated into the different materials.

- Interesting project aimed at fundamentals that will enable spin off projects upon completion

**Interested with Change**

- Along with different resins, including the use of additives that reportedly promote the digestion of polymers would be of interest.

- This seems to be a very broad topic and not sure how a call for proposal would be developed. The seed concept would be strengthened if a well-defined problem is defined, possibly define a set of polymers, and conditions.

- Long term and short term goals need to be spelled out. The seed concept idea is large enough
that a researcher can only tackle a small portion of the project. Scope definition is required to help members vote.

**Additional Comments**

- This will also help focus what specific chemistry will have the best probability of creating a compatible but also providing sufficient primary use properties.

- It sounds like the cost of this project might be greater than the ~50k level. Might be one for the “longer term” project model discussed yesterday.
Very Interested

- We would be interested in developing nanocellulose, specifically CNC based coating materials that can be functionalized for different packaging applications. Is the cost and life cycle assessment of the product critical?

- Extremely important for packaging barriers

- Crosses many industries and applications.

- There are a lot of desired properties that need to be met simultaneously, but it should be feasible to accomplish.

- This is a significant challenge as you are attempting to create a degradation pathway that does not compromise the primary function of the coating, which typically is a protective coating that is highly resistant to degradation. This would be exciting if there were the breakthrough discovery here. My concern is that within a 1 year timeline that there may not be enough effort placed here and I could see this being a longer horizon project.

- These are interesting. I think producing an energy curable material that is still capable of being decomposed is challenging but quite possible. For example a hydrophobic cross-linked polymer that is designed with a "weak" link in the backbone to allow decomposition is something that should be very possible. I think this project has some interesting opportunities.

- We are developing a functional (OVTR and WVTR barrier) coating for this purpose. The technology is not yet water-born, but is rather being developed to be solventless. However, we may work to develop the formulation for water-borne application.

- Very interesting topic, this has been a need in paper based packaging for various functional needs such as sealing, barrier, printability etc. Would also be great if we can have recycling as a functionality as well.

- Are there specific functional groups that you anticipate are better suited for your process?

Interested

- Functionalities need to be separated. As stated the requirements of surface coating are
somewhat contradicting.. stable and degradable?

- Very relevant, worthwhile given measurable performance expectations of both the coating and the study/research milestones.

- Creating a coating that is compostable that improves the deficits of compostable packaging is a real need for further adoption of these materials.

- Interested particularly if this could enable compostable packaging (like paper-based) with range of properties like moisture barrier, ability to print, aesthetics etc.

- I think this is a worthwhile project to have functional coatings that are designed to compost or facilitate compostability. This could be relevant for packaging materials for many industries. Good luck.

- The market has not looked nearly as closely at cured coatings and controlled degradation as it has at thermoplastics. Would be a good area for some basic research on curable coatings.

Interested with Change

- John Deere is interested for steel, Aluminum, and composite substrates. The coatings must be durable under a variety of conditions.

- I think there needs to be more definition of what is meant by functional. Otherwise, the project will be too broad.

- Is there a possibility to combine with the golf tee coating concept?

- Understand the need. To focus, suggest either pick low-hanging fruit of known compostable chemistries and brainstorming what functionalities to go after; or pick a target functionality/set of performance properties, and come up with ways to tackle that.

Abstain

- Coatings are not part of our division’s business.
Project: (SC-005) Bioplastic (PLA, PBS) Compounds for Thin Wall Application
Phase: New Proposal
Project PI: Baiagern, Nawamawat, Loijai (PTT Global Chemical)

Level of Interest
Very Interested - 1
Interested - 7
Interested with Change - 7
Not Interested - 7
Abstain - 4

Very Interested
• Need more info from GCI about performance targets. Would love to see our CB2 researchers submit proposals on this topic, without reinventing wheels.

Interested
• "Thin Wall" should be defined for improved clarity of what is needed.
• Need to clarity on performance properties
• Good topic. Identify specific focus.
• Interested in the process ability aspects of this project.
• Need better scope definition from author. Expect that they would like to develop PLA/PBS blends at a higher level of usefulness.
• What are challenges with PLA and PBS in terms of thin packaging and would modifications for thin wall plastics change the chemistry?

Interested with Change
• Not sure whether this is about compounding polymers together, or creating a new Bioplastic. I would support this if it was a new polymer type project.
• The seed concept would be strengthened if more details on the problem could be provided.
• Will have to align internally to gauge level of interest
• There is a lot of work that has and continues to be done with existing biopolymers, biopolymer blends, composites, filled and unfilled, so what is different from this project?

A major processor needs to be involved, who would that be?
• I think this needs to defined better. PLA is already used in clam shells etc. Is it asking to create modify a PLA or PBS material that can be microwaved, like a tray in a frozen meal?
• Need to see a clear scope of this project on improving the deficiency of PLA/PBS blends and
relating them to end use applications.

- There is a good amount of literatures available on the topic, it would be interested to know the exact metrics of interest with the industrial need.

**Not Interested**

- May be applicable to JD merchandising, but not a priority.

- Not clear what this adds to existing knowledge or what gaps are being addressed.

- Success in this project would be really close to developing a product and likely pushing to far from pre-competitive research. I think we would need to identify the fundamental challenge to be addressed and make sure it has broader impact to a number of center members.

- This project is outside my scope of work; however, I do understand the need for improvements for thin-wall applications for bioplastics. It may be worth your inquiry to talk in more detail about this project with Danimer Scientific.
Project: (SC-006) Bioplastic Compounds (PLA, PBS) For Stretch Wrap or Stretch Film Application
Phase: New Proposal
Project PI: Viboon Pungprasert (PTT Global Chemical)

Level of Interest
Very Interested - 1
Interested - 9
Interested with Change - 6
Not Interested - 6
Abstain - 7

Very Interested
- Bio-based and biodegradable stretch film applications are of interest.

Interested
- Should include parameters to better define the needs (i.e. extent of stretch, control material to compare, etc.).
- Interested to see our CB2 researchers submit creative ideas on this topic, without reinventing wheels.
- While very similar to C5 and possibly combined, this appears to be potential large market with a significant reduction in waste.
- Could be combined with SC 6 into a single project. Technology for combining PBS and PLA to take processing and properties to a higher level of commercial attractiveness.
- Good Focus... A replacement for saran wrap?
- Stretch wrap is a big waste in all industry. Recycling it is limited. Most ends up in a landfill. A compostable/biodegradable stretch film is needed. We explored this some previously with the modified starch project. PLA heat shrink films/sleeves are already commercially offered from companies like psi.
- Seems like a fundamental need for enabling compostable packaging but would like to see it focused in a particular application space where the need is critical. Ideally, we should be designing out unnecessary packaging.
- Is this possible?

Interested with Change
- Making biopolymer films stretchier/tougher is a bigger need than just stretch film. Could stretch film be a target space for a broader project? There are many PE films that need to be replaced with films that have a safer end of life.
• A compostable stretch wrap would be of interest to our business to aid with our distribution packaging, however I wonder if this could be combined with the other ideas surrounding PLA/PBSA and be polymers.

• Combine with SC5.

Need to align internally to gauge level of interest.

• Seed concept needs to be refined. Add more specifics for performance requirements.

• This was not clear enough scope to make a recommendation. Consider combining with SC5 and address biobased thin wall and stretch film together in one project.

• Project needs to be more clearly defined. Seems to be specific product development related and not pre-commercial technology.

**Not Interested**

• My impression is that there is similar, commercial activity underway.

• Again need to identify the fundamental challenge to be addressed. As written seems very close to product development not pre-competitive research.

**Abstain**

• I know I have heard this topic mentioned before in seed concepts (potentially championed by John Deere). I cannot say what prevented the project from taking off.

• Interested for end use, not interested in core-research
Very Interested

- I think it should be sustainable and biodegradable. Question is whether bioPP is biodegradable? Can we engineer it to? This should be combined with sustainability as well.

Interested

- Applicable topic to many industry partners. Research must go beyond oxo-degradable additives, though, and focus on true enzymatic degradation of polyolefins.
- There has been work to meet these goals from polyesters using long-chain diacids and diols that mimic the properties of polyolefins, however, it is difficult to see how this would be cost competitive with petrochemical polyolefins.
- Combine with SC16. Long linear chain monomer aliphatic polyesters closely resemble the properties of polyolefins.
- Yes, interesting goals. The materials and products should meet or exceed biopreferred labeling requirements.
- Builds into the idea to understand what makes polymers biodegradable #3 so could the focus be understand functionalities that could be added to pp or PE or other polyolefins, to make them compostable, in effect a targeted approach to designing a new class of polymers.
- This could be worthwhile in applications beyond packaging, IF the work doesn't include oxidative degradation.
- What are the proposed degradation conditions?

If new backbone blocks are introduced that are fully degradable, how much of the process are you anticipating to be enzymatic? What are the upper and lower temperature limits of your manufacturing process? Are you interested in enzymatically functionalized building blocks, specifically, to incorporate into your existing process?

Interested with Change

- Need clarity on scope. Polyolefin biodegradation is scientifically very challenging. May be good to put efforts in materials which can function like olefins and degrade as well.
• Pure polyolefins are difficult to degrade. That being said if you designed a oligomeric polyolefin (5-10 repeat units) that had an acid/alcohol end group and chain extend it to produce the occasional ester repeat unit, this may allow for the decomposition of the polyolefins without significant impact on the properties.

• I think there are several companies out there already that have created products in this space. They have been/are used with agricultural films. The problem cited is that they olefin is still in the soil at the micro/nano level. Maybe this is the project. The creation of olefins that are completely digested.

• Polyolefins are NOT digestible. The better description of the project might be to create newer classes of biopolymers that mimic the properties of polyolefins, preferably can be run on existing converting methods, but can be consumed as food sources by the earthâ€™s biome/microorganisms. This would then tie into SC3 seed proposal and SC16.

The way it is written is dangerously close to sounding like oxo degradation!

• The seed concept would be strengthened with more definition on the requirements. For example, is the goal to develop a PE "like" material that is degradable or is it to have a PE material actually degrade? Degradable PE's would be game changer (if it was truly degradable), but represents a large challenge.

• The challenge to identify enzymatic or microbial systems capable of degrading pure polyolefins seems very daunting. Is there a specific path the project has identified to being exploration?

**Not Interested**

- There have already been a few companies in the past that have proposed an additive to make polyolefins biodegradable.

- Seems like a project of wishful thinking. Degradable PE and PP is a huge undertaking.

- There has been some work in finding low yielding enzymes for biodegradation of heteroatom-containing conventional polymers(poly esters and copolymers like PET), yet I have not encountered a study that has any evidence of polyolefin carbon metabolism by microorganisms to date.

- Seemingly insurmountable challenge for neat pp or pe.

  Would modified backbones be in scope that would allow microorganisms to attack?

- If the goal is to take existing PP/PE type materials and incorporate additives to make them "degrade" analogous to pro-oxidant additives, then I cannot support. The general consensus among plastics recyclers, many governments, NGOs, global companies etc. is that additives that promote fragmentation and micronization of polyolefins is very risky and not a path that should be pursued.

**Abstain**

- This sounds great but is well outside my ability to evaluate. May also have an issue of scope. Or being feasible at all.
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 1 (University of Georgia) - May 22nd, 2019

Project: (SC-008) Reduce Fogging Characteristics of Natural Fibers
Phase: New Proposal
Project PI: Jim Preston (RheTech)

Level of Interest
Very Interested - 3
Interested - 8
Interested with Change - 2
Not Interested - 6
Abstain - 12

Very Interested

• Could perhaps focus to co-polymers/polymer additives with covalent bonding? This could have wide-ranging uses and I strongly support for health purposes, e.g., indoor air quality.

• A challenging, yet clear goal project.

• This is a very broad topic when considering all materials that are challenged here. More specifics should be added.

Interested

• Good requirement. Should look into several approaches- pretreatment, final product surface treatment, etc.

• While the concept represents a large problem, more details on the source of the outgassing should be better defined. For example, do we know fibers are the major source or is the resin the significant source?

• This may be a worthwhile study IF there is proof of a more significant outgassing issue with natural fillers.

• Consider whether the project scope could also be determining processing conditions to scrub offgasses to eliminate fogging. Low or no-offgassing products could be highly valued beyond automotive applications. Indoor air quality emissions in commercial building products and residential building products is a growing market pressure.

• Has there been any work to study and isolate the contribution of natural fibers to outgassing? I was not aware that the incorporation of natural fibers increased the fogging characteristic. What mechanism is responsible for this phenomenon?

Interested with Change

• Project would benefit from better definition of substrate, fiber etc

• Light-fastness of materials is a concern for polymers and materials. More detail needed.
Not Interested

- As far as I know, Deere equipment does not have fogging issues from outgassing of plastic parts and this would be a low risk with bioplastics in our cabs.

- A general issue of materials. Need a more focused rescope to specify what type of product needs to be examined.

Abstain

- We have no general interest in this project.

- Not clear to me based on discussion that the fibers are a cause for the fogging. If there is additional info that could clarify that, I could be supportive.
Project: (SC-009) UV Stabilization of Natural Fibers

Phase: New Proposal

Project PI: Jim Preston (RheTech)

Level of Interest
Very Interested - 3
Interested - 12
Interested with Change - 4
Not Interested - 5
Abstain - 9

Very Interested

- There is potentially a good biobased solution for this.
- A catalog or database of UV resistance based on fiber type and length is valuable.
- There is a possibility that an acrylic and acrylate coating on natural fibers can be applied but this would require fibers to be fully coated, or at least enough coating to limit the UV exposure. This would add to the cost of the natural fiber.

Interested

- It is important to identify the mechanisms behind the discoloration. If color/properties of natural fibers can be stabilized, other industries will be interested.
- It is hard to protect materials from UV. We don't want to give the impression that we are completely protecting from UV. So wording may have to change to better UV retardants.
- More clear plan for how to tackle this issue. Is the project seeking a coating system for natural fibers that would mitigate UV degradation? Are we seeking an additive that can be used as a part of a fiber functionalization scheme, which is desirable anyways to increase interstitial performance.
- Functionalizing the natural fiber for UV protection before compounding would be one of the area of exploration here.
- Adding some inorganic materials may help delaying the degradation. It is all in the kinetics.
- Good target with potential impact on other cellulose based materials. Discussion would seem to leading to inexpensive modification of the hydroxylated surface of the cellulose fiber.
- First approach could be to stabilize the matrix with us absorbers and light stabilizers. But likely getting to the core of the issue by addressing the filler/ fiber will be challenging but also a breakthrough
- This could be quite challenging.
- I think this has wide reaching possibilities. The key would be to unlock the appropriate chemistry to treat the fibre with to enable uv stabilisation if the cellulosic fibre.
I have some information on a bio based additive that may enable this to be achieved that I could share. Please feel free to email me:

Martin.cockroft@futamuragroup.com

- What is the natural fiber additive that is impacting the UV stabilization? Interesting project to try to leverage biofiber in applications where it isn't performing today.

**Interested with Change**

- Need to focus/understand mechanism. Perhaps look at free-radical scavengers that still allow biodegradability.

- Suggest to reframe the project, semantics, however, the need to develop natural fiber materials that have reduced tendency to develop chromophores from UV-A, UV-B exposure would potentially be a good project to consider.

- If we could broaden this to fundamentals and development of safe, green additives that could stabilize materials against certain targeted environmental issues such as UV, oxidation, etc. without harming biodegradability it could apply to a range of industries.

**Additional Comments**

- Hart mentioned acetic anhydride treatments on wood to stabilize.
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 1 (University of Georgia) - May 22nd, 2019

Project: (SC-010) Biobased Polymer For Fiber
Phase: New Proposal
Project PI: Kellie Ballew (Shaw Industries Inc)

Level of Interest
Very Interested - 2
Interested - 6
Interested with Change - 3
Not Interested - 5
Abstain - 12

**Very Interested**
- I agree that a lot of the fundamental research on the structure property relationships of "novel" polyamides and their processing characteristics would be a great project for this group.

Nylon 5,5 is an excellent idea.

**Interested**
- There are lots of biobased options in biobased polyamides, some with similar properties to Nylon 6,6. The challenge to access the biobased nylon monomers at costs closer to adipic acid and HMDA.

One option might be nylon 5,5 leveraging Jason's glutaric and PMDA from lysine.

- We are interested in biobased nylon fiber for apparel applications.
- Looking for new biobased materials
- Is this something that could be addressed via Dr. Cochran’s polyamide 2019 project? I think we need to further refine the expectations of this concept, but there is surely interest in a more biosourced, fiber system that could be used for carpeting or other soft surfaces.

- The discussion about the production of nylon 5,5 using glutaric acid and the proposed pentamethylene diamine bio-based monomers would be a very interesting study for us to examine further.

We would like to investigate the properties of such a polymer if there is support from industry sponsors.

**Interested with Change**
- Specify target product properties.
- Not looking for a bio version of PA 6 or PA 6,6. Want a biosourced polymer that does what? Any more information here would be very helpful.
• I'm interested at looking a new polyamide systems, however let's target specific properties/better define what is desired.

**Not Interested**

• This is a complex project. Companies with more resources have already been trying to address this.

• Deere would not be able to utilize biobased polyamide fibers in the short term.

**Abstain**

• I don't believe I can add to this.

• I would like to hear a Kellie/Erik refined concept.

  Performance criteria should also be clarified.

• Not applicable for me, but I think this could be a useful project if it was generalized to understanding fundamentals of nylon-type materials that are sourced from more easily renewable sources (e.g. odd-odd example given in the meeting).
Project: (SC-011) Biobased Polymer to Replace PVC
Phase: New Proposal
Project PI: Kellie Ballew (Shaw Industries Inc)

Level of Interest
Very Interested - 3
Interested - 17
Interested with Change - 5
Not Interested - 3
Abstain - 1

Very Interested
• Like it!
• this is really a difficult concept, but i see this as a holy grail.
• Love this but it is huge. Would it be possible to narrow the scope and/or provide a specific example.
  For example narrowing it to flooring, describing the performance criteria and then providing an example HPD so one can see which properties are from the polymer and which are supplemented by additives in the current state?

Interested
• There is a company called Earth Renewable Technologies that produces a wide range of biobased and biodegradable bicomponent fibers. They are located in Greer, SC. (Kelly Williams). I know they make pigmented versions as well.
• PVC is an amazing and versatile polymer that would be hard to directly replace with a single polymer. Probably better to focus on separate replacements for rigid PVC and soft PVC.
• Most interested in foamed PVC seals with a pressure sensitive adhesive on one side.
• This is one that has a good score on the humanity scale. Good project! We are always in search of replacement for PVDC coatings. (Kelly Williams)
• Clearly this has a world value, so a very interesting project of very high potential commercial value. For us a bio replacement for PVDC would also be of interesting.
• Does not apply to Evolve Golf, but a great big target.
• This could be a game changer, but assume this would be a long term project and should include multiple institutions as proposers.
• This is very ambitious, but if a PI could arrive at a roadmap with a understandable route and a reasonable timeline, I imagine it would be popular.
• It's sounds like this is an approachable, yet very challenging proposal that would have huge
impact. Let's change the world!

• It is going to be very challenging project.

• Interested in technology to find PVC replacement but cost need to watched.

• Intriguing -- I'd like to see proposals from our CB2 researchers. Per Dean, think of "new linoleum". ...Shaw, please specify properties targeted, e.g., hardness for flooring. Also realistic cost targets.

• We are developing bio-based PU monomers for coating and foam applications. The PUs used in these materials may provide the material properties for a broad range of both soft and stiff applications. There are indeed differences in say foams and coatings when compared to injection molded components made from PVC. But given the broad range of PVC material properties, there is likely an overlap for certain applications.

• This is an extremely broad initiative that would require more definition in scope prior to concept approval. For instance, could initial studies be focused in a single application as opposed to the myriad listed? A single material solution may not be practical for every application where PVC is implemented.

Interested with Change

• Need to better understand the characteristics of of the needed. Interested in biobased only or a biodegradable/compostable fiber?

• Interesting and very big challenge. I'm thinking of DSM's compounds used to replace PVC wire and cable. Challenge to greater acceptance is cost. Flame resistance and fire propagation of the resin would be a primary.

• There is a lot of interest for PVC alternatives across many industries (lots of different application requirements). I would like to see more specificity in the project proposal as to what material sets would be explored and what specific properties would be initially looked at.

• PVC is a material with very broad applications and uses. This problem needs to be split into smaller objectives. Solutions to replace rigid PVC will be very different than flexible. Construction will be different than packaging or consumer use.

• Define hardness range to narrow down the challenge. Bio based TPU may be an option.

Not Interested

• This is a complex project that would require a large team with a lot of resources. Probably not practical for a CB2 project.

• Understand the need. Many companies including mine, have zero PVC policies.

• Not relevant to my industry directly but seems like an important area of study due to the prevalence of PVC today.
**LIFE Form Review**

**CB2: Seed Concepts for 2020 Projects_Round 1 (University of Georgia) - May 22nd, 2019**

**Project: (SC-012) Biobased Adhesive System**
**Phase: New Proposal**
**Project PI: Kellie Ballew (Shaw Industries Inc)**

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### Very Interested

- This has potential for an energy curable solution, however, the availability of a 100% biobased energy curable polymer is not commercially available. The building blocks need to be developed first. This would be a longer term project if energy curable was considered.

- Achievable goals.
  Talk to USDA Peoria Lab. Related work is going on at NCAUR.

- Very much interested in a compostable adhesive which can be used in packaging application such as folding cartons.

- 100% support this project. Adhesives are used across a wide range of industries so would be a project that everyone in the CB2 would benefit from in some way. Itâ€™s also very achievable in my view.

- This is of high interest to a variety of sectors (including packaging) in which multilayer structures are laminated or assembled.

- This is a good compliment to SC4 as adhesives represent a large-range of necessary materials that need to be environmentally safer. The adhesive suppliers are large global companies who are either not putting energy into this, not enough energy into it, or simply donâ€™t know what to do because they donâ€™t know what new tool kit of materials to work with. There is also a challenge in trying to find single formulations that do as many applications that current adhesives have been refined to do. There has to be acceptance that solutions will initially be fragmented by application that will then be optimized also over time.

- Our polyurethane project also has some overlaps in terms of the use of the pre-polymers as a strong covalent adhesive. These glues are 100% bio-based on a carbon basis. They were originally designed to glue lignocellulosic materials and timber products. We are currently working on scaling this material to the 1-2 kg batch scale.

- Will the lifecycle analysis be interested on the bio-based adhesives?

### Interested

- Interested in a low cost, bio-based cyanoacrylate or anaerobic adhesive. Another concept is to use bio-based epoxy and urethane chemistries for structural applications on metals and
composites.

- Be best to focus in on one of two specific applications.
- Would be interesting to see properties of incumbent adhesives to be replaced.

**Interested with Change**

- Could be interesting if the adhesives targeted are also used to seal corrugated boxes.
- There have been several adhesive projects and proposals in the center. Should take a look if those materials would be applicable.
- Interested in characterizing and summarizing what is out there now - the state of the art. Measure and evaluate shortcomings. Make recommendation for improvement.

**Not Interested**

- I feel this is outside of scope of CB2.
Very Interested

- Good challenging project with a clear goal.
- The promise of furanic-based polyesters is very attractive. Doing this work now, could help with the head-winds from PET that these polyesters have faced and will continue to face. Recycling the blends is in the seed and any project should definitely look at it. The APR will want to see that work when these polymers start to get adopted.
- Interested in blown films and filled, injection molded parts.
- This has the potential to impact a range of markets/industries with the development of knowledge..
- This material is coming for sure. Chemists in the room want high purity monomers to play with! Send me some (Locklin).
- These are materials that have very exciting thermal properties and I am very interested in further looking at these compounds.
- PEF was developed in response to Coca-Cola's initiative for a bio-based bottle. This needs to be expanded to other areas and should be explored by this group absolutely.
- Let's unleash polymer-grade material on our CB2 researchers. Would love to see variety of applications, chemistries, and blends proposed.

Interested

- Interested in extrusion coating behavior of PEF and its blend.
- General interest in the processing and properties of these new materials. USDA can help with the evaluations.
- Good project - new material, wide-ranging potential, and it needs to be now reduced to the fit between material science/application. Likely a 2-year project unless agreed that it can be broken up into a first phase exploration focus with a second phase of picking logical application paths to further develop, including IP.
**Interested with Change**

- Also consider thermoset packaging applications.

- We are interested in PEF and the work from Steve Miller’s group on these materials. As these materials are bio-based, we would like to characterize the biodegradation profiles of such materials, in both pur and blended states.

  Defining the end-of-life consequences of such polyesters would add much to the PEF/PTF work.

**Not Interested**

- Not applicable for my industry but looks like a good practical project to enable use of new materials.

- Good idea, sounds very viable.

  How would PEN project synergies w this proposed?
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 1 (University of Georgia) - May 22nd, 2019

Project: (SC-014) Polyamides Derived From Ozonolysis of Oleic Acid or Difunctional Diacid Mixtures
Phase: New Proposal
Project PI: Erik Hadberg (ADM)

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<td>Abstain - 8</td>
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**Very Interested**

- Nice idea. Some preliminary work in this area has been reported. Expanding on these results would be interesting. Another area to investigate would be other diamines (C11 and 13) in combination with even or odd numbered diacids. Looking odd/odd and odd/even components.
- These materials are interesting as they are not very well known from a literature standpoint and so further development of these materials would be interesting.
- Exploring properties and ultimate applications of bioderived nylons should be explored by this group certainly.
- Could be a great partnership project to see what fiber properties can be identified/understood/utilized. This would, of course, require deep engagement in my fibers technical team (not me). Thanks, Kellie Ballew
- Interesting to continue to push polyamide space.
- Could be a great partnership project to see what fiber properties can be identified/understood/utilized. This would, of course, require deep engagement in my fibers technical team (not me). Thanks, Kellie Ballew

**Interested**

- What has been done already and what remains? It would be good to build a table of data from existing systems.
- Interested in fiber-filled injection molding grades of these new materials. Also very interested in 3-d printed various polyamide resins.
- Interesting but this is a long term project and should be multi-institutional.

**Interested with Change**

- Need to understand the "Bio" part of this better....
- Ozonolysis is an interesting technique, however, it could be difficult to implement at large
Not Interested

- Again an interesting project proposal, but not aligned w our priorities.

Abstain

- Very interesting fundamental study. I would like to follow the progress of this project should it be carried forward.
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 1 (University of Georgia) - May 22nd, 2019

Project: (SC-016) Bioderived and Biodegradable Polyesters Similar to Polyethylene
Phase: New Proposal
Project PI: Erik Hadberg (ADM)

Level of Interest
Very Interested - 12
Interested - 14
Interested with Change - 2
Not Interested - 1
Abstain - 3

Very Interested

• Lot of potential diacid/diol combinations can be investigated. Once again odd/even and even/even combinations can be interesting. Also potential for making 100% biobased polyesters.

• I think, combined with the other seed concepts, this is a good idea and needs to be explored.

• Polyolefin alternatives using polyesters is very interesting from a biodegradable standpoint.

• Always a fan of looking at uses for longer-chain diacids and diols.

• Polyester chemistries are used in our energy curable oligomers and this would have a significant impact on developments within our company.

• Good idea, worth exploring at fundamental level. Can have wide ranging impact.

• Yes please.

• Absolutely the type of project we should support. We need to develop more of these new polymer types.

• Are you specifically interested in biobased production of monomers?

Is this specific to recombinant proteins in vitro, or an in microbe production production process?

What is the range of monomers that you are interested in evaluating?

Interested

• A great seed concept, however this is a long term project and should be multi-institutional and include a significant LCA/TEA component in the proposal.

• Would these be cost competitive with polyolefins?

• General interest in developing new biobased polymers- USDA

• Definitely interested in this seed concept! We need more materials to build from.
• Project seed concept has a more realistic scope than SC7. Looking closely at the limits of synthesis, properties and degradation across this area is of interest.

• Interested in blown film applications.

• How to deliver PE-like properties from biodegradable materials particularly for films, nonwovens would be particularly interesting.

• Again, this fundamental study for determining the properties of these long chain aliphatic polyesters would be of interest to our group. We may be able to help in the end-of-life characterization, and materials property characterization at the UGA New Materials Institute.

**Interested with Change**

• Hard to see the promise here of long-chain polyesters. Baskem has bioderived PE. PEs can be made to degrade.

• Good concept, could envision support if can be implemented also as polyester polyol

**Additional Comments**

• And look at multi-functional acid-alcohol monomers, as available (e.g. C16 omega-OH fatty acid).
LIFE Form Review
CB2: Seed Concepts for 2020 Projects_Round 1 (University of Georgia) - May 22nd, 2019

Project: (SC-017) Use of Nanocellulose Materials in Concrete For More Strength and Durability
Phase: New Proposal
Project PI: Somayeh Nassiri (Washington State University)

Level of Interest
Very Interested - 2
Interested - 8
Interested with Change - 1
Not Interested - 10
Abstain - 9

Very Interested

• Will be good for feedstock providers -- lignocellulosic fibers
• We would happily support this, I could both support with novel or interesting CNF to try and/or other cellulosic feedstocks, and I believe this could be a very valuable project, and similar work in this area has shown very positive results.

I would very much like to discuss this:

Martin.cockroft@futamuragroup.com

Interested

• Will the cost be a challenge for the he application?
• General interest.
  USDA/US Army Corps have done some work in this area.
• Interested in developing understanding around reinforcing impact of nano-cellulose which can be applied for various polymer blends, substrate as well in paper making process.
• Not sure this falls into the scope of CB2 but it is interesting.
  Is this for porous and/or conventional cement?

Interested with Change

• There has been a fair bit of work in this space. See Jeff Youngblood's (Purdue) work. The CNC and CNF are very good water reducers for concrete.

Not Interested

• No industry partners were a champion
• Great concept. Concrete improvement is outside this group's focus.
• Not interested
• Not interested in expanding to concrete composites within this center.

Abstain

• Concrete isn’t poisoning the oceans or littering our forests. It is unclear how this SC compares to work already being done around the world.

• How would biodegradable additives affect strength over time, as the cellulose fibers decompose. Would the cellulose fibers decompose within the concrete matrix? Would there be a consequence in terms of material strength with a degradable filler/additive.

• How would biodegradable additives affect strength over time, as the cellulose fibers decompose. Would the cellulose fibers decompose within the concrete matrix? Would there be a consequence in terms of material strength with a degradable filler/additive.

• Concrete isn’t poisoning the oceans or littering our forests. It is unclear how this SC compares to work already being done around the world.
2\textsuperscript{nd} ROUND OF LIFE FORM OF SEED CONCEPTS
New Proposals: Level of Interest

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Project: (SC-001) 100% Biobased Zero VOC Clear Varnish for Wood Products
Phase: New Proposal
Project PI: Benjamin Maloy (Evolve Golf)

Level of Interest
Very Interested - 1
Interested - 2
Interested with Change - 0
Not Interested - 5
Abstain - 1

Summary of Responses to IAB Comments

Not Interested

- Not research; needs a lower TRL
- low VOC Coatings are Low priority
Project: (SC-002) Rigid/Tough Post Consumer Polypropylene Compounded w/Natural Fibers & Biobased Resins for Injection
Phase: New Proposal
Project PI: Benjamin Maloy (Evolve Golf)

Level of Interest
Very Interested - 1
Interested - 2
Interested with Change - 0
Not Interested - 3
Abstain - 2

Summary of Responses to IAB Comments

Not Interested
- Not research, need a lower TRL

Abstain
- Seems to be a simple project that could be easily facilitated outside of this forum.
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 2 (University of Georgia) - June 12th, 2019

Project: (SC-003) Understanding the Structural Requirements of Compostable Polymers
Phase: New Proposal
Project PI: Martin Cockroft | Kelly Williams (Futamura)

Level of Interest
Very Interested - 3
Interested - 3
Interested with Change - 0
Not Interested - 1
Abstain - 1

Summary of Responses to IAB Comments

Interested

- The database will be valuable
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 2 (University of Georgia) - June 12th, 2019

Project: (SC-004) Developing Functional Water-Based or Energy-Curable Coatings from Compostable Materials
Phase: New Proposal
Project PI: Martin Cockroft | Kelly Williams (Futamura)

Level of Interest
Very Interested - 1
Interested - 0
Interested with Change - 0
Not Interested - 4
Abstain - 2

Summary of Responses to IAB Comments

Not Interested
• not interested
LIFE Form Review
CB2: Seed Concepts for 2020 Projects_Round 2 (University of Georgia) - June 12th, 2019

Project: (SC-005) Bioplastic (PLA, PBS) Compounds for Thin Wall Application
Phase: New Proposal
Project PI: Baiagern | Nawamawat | Loijai (PTT Global Chemical)

Level of Interest
Very Interested - 1
Interested - 1
Interested with Change - 0
Not Interested - 5
Abstain - 1

Summary of Responses to IAB Comments

Interested
• Interesting concept
Project: (SC-006) Bioplastic Compounds (PLA, PBS) For Stretch Wrap or Stretch Film Application
Phase: New Proposal
Project PI: Viboon Pungprasert (PTT Global Chemical)

Level of Interest
Very Interested - 1
Interested - 2
Interested with Change - 0
Not Interested - 3
Abstain - 0

Summary of Responses to IAB Comments

Very Interested
- Very interested

Interested
- This could be of use to a wide range of the IAB, who distribute using stretch wrap. Would be of clear environmental benefit.
- Ensure additives evaluated for this application are designed to degrade.
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 2 (University of Georgia) - June 12th, 2019

Project: (SC-007) Biodegradable Polyolefins
Phase: New Proposal
Project PI: Patima Wongmanit (PTT Global Chemical)

Level of Interest
Very Interested - 1
Interested - 2
Interested with Change - 0
Not Interested - 3
Abstain - 1

Summary of Responses to IAB Comments

Interested
- In principle a good idea, and these sorts of materials could be used as building blocks for other areas (coatings etc). Would be worried about proving there is no risk on "micro-plastic" formation, as with oxo-degradables etc!

Not Interested
- Not interested
- Many governments, recycling associations and major companies are against the use of additives to promote environmental fragmentation and degradation of polyolefins which would lead to microplastics. See the EU scientific report on the use of pro-oxidant additives.

Abstain
- Concern with incomplete degradation/formation of microplastics
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 2 (University of Georgia) - June 12th, 2019

Project: (SC-008) Reduce Fogging Characteristics of Natural Fibers
Phase: New Proposal
Project PI: Jim Preston (RheTech)

Level of Interest
Very Interested - 1
Interested - 2
Interested with Change - 0
Not Interested - 4
Abstain - 0

Summary of Responses to IAB Comments

Interested

• interesting concept for operator stations and interiors

Not Interested

• As discussed in the forum, this is already an issue with standard materials and likely to be even harder to solve with bio materials included? However this is not really in our area of expertise so may be missing something.
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 2 (University of Georgia) - June 12th, 2019

Project: (SC-009) UV Stabilization of Natural Fibers
Phase: New Proposal
Project PI: Jim Preston (RheTech)

Level of Interest
Very Interested - 2
Interested - 1
Interested with Change - 0
Not Interested - 3
Abstain - 1

Summary of Responses to IAB Comments

Very Interested

• very interested
Project: (SC-010) Biobased Polymer For Fiber
Phase: New Proposal
Project PI: Kellie Ballew (Shaw Industries Inc)

Level of Interest
Very Interested - 1
Interested - 3
Interested with Change - 0
Not Interested - 5
Abstain - 0

Summary of Responses to IAB Comments

Not Interested

- not interested
- Not of specific interest to my company, however I can see the general merit of the project.
Project: (SC-011) Biobased Polymer to Replace PVC
Phase: New Proposal
Project PI: Kellie Ballew (Shaw Industries Inc)

Level of Interest
Very Interested - 1
Interested - 1
Interested with Change - 0
Not Interested - 6
Abstain - 0

Summary of Responses to IAB Comments

Interested
• I think this could be a very interesting concept.

Not Interested
• not interested
Project: (SC-012) Biobased Adhesive System
Phase: New Proposal
Project PI: Kellie Ballew (Shaw Industries Inc)

Level of Interest
Very Interested - 0
Interested - 2
Interested with Change - 2
Not Interested - 3
Abstain - 0

Summary of Responses to IAB Comments

Interested
• Like this idea but like it even better if one could assess the adhesive for compostability.

Interested with Change
• I think this is a great idea with wide sweeping interest. I would be interested to know if the intention is just to focus on the bio content, or also to try and drive the adhesive to be compostable or biodegradable, i think there is value in driving its end of life!

• Interested in broader development of compostable adhesives that might be applicable to wider range of industries.

Not Interested
• not interested
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 2 (University of Georgia) - June 12th, 2019

Project: (SC-013) PEF Blends for Packaging and Durable Goods (SC-006 (R))
Phase: New Proposal
Project PI: Erik Hadberg (ADM)

Level of Interest
Very Interested - 1
Interested - 1
Interested with Change - 0
Not Interested - 4
Abstain - 1

Summary of Responses to IAB Comments

Very Interested
- very interested
Project: (SC-014) Polyamides Derived From Ozonolysis of Oleic Acid or Difunctional Diacid Mixtures
Phase: New Proposal
Project PI: Erik Hadberg (ADM)

Level of Interest
Very Interested - 0
Interested - 3
Interested with Change - 0
Not Interested - 5
Abstain - 0

Summary of Responses to IAB Comments

interested
Project: (SC-015) Biodegradable Polycondensation Elastomers Derived From Glycerol and Levulinic Acid

Phase: New Proposal

Project PI: Erik Hadberg (ADM)

Level of Interest
Very Interested - 3
Interested - 2
Interested with Change - 0
Not Interested - 1
Abstain - 0

Summary of Responses to IAB Comments

Very Interested

• very interested

• For me this is exactly the sort of fundamental study that has the chance to provide a new range of raw materials to work with, and should be supported.

Interested

• interested in the development of biodegradable elastomers, in particular
Project: (SC-016) Bioderived and Biodegradable Polyesters Similar to Polyethylene
Phase: New Proposal
Project PI: Erik Hadberg (ADM)

Level of Interest
Very Interested - 1
Interested - 5
Interested with Change - 0
Not Interested - 2
Abstain - 0

Summary of Responses to IAB Comments

Very Interested

- Once again, a great idea for a fundamental study.

Interested

- Interested
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 2 (University of Georgia) - June 12th, 2019

Project: (SC-017) Processing Waste Materials and Nanocellulose to be Used in Concrete for Strength and Durability
Phase: New Proposal
Project PI: Cockroft | Nassiri | Walcott (Futamura | WSU)

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Summary of Responses to IAB Comments

Not Interested

- not interested
Project: (SC-018) Moisture Sensitivity of PLA/PBS Blends During Ultrasonic Welding
Phase: New Proposal
Project PI: Bill Reed (Emerson/Branson Ultrasonics)

Level of Interest
  Very Interested - 0
  Interested - 1
  Interested with Change - 1
  Not Interested - 4
  Abstain - 1

Summary of Responses to IAB Comments

Interested with Change
  • Perhaps we could also include other materials and/or coatings into the study?

Not Interested
  • not interested
LIFE Form Review

CB2: Seed Concepts for 2020 Projects_Round 2 (University of Georgia) - June 12th, 2019

Project: (SC-019) Glycerol-Based UV Curable Materials for 3D Printing of Hydrogel
Phase: New Proposal
Project PI: Ashby | Zhang | Liu (REG | WSU)

Level of Interest
Very Interested - 1
Interested - 0
Interested with Change - 0
Not Interested - 4
Abstain - 2

Summary of Responses to IAB Comments

Not Interested

• not interested