APPLICATION CHECKLIST

Use this checklist as a tool to ensure that you have all of the components of the application package. Please note, this checklist is for your use only and does not need to be included in the package.

☐	Application
☐	Transmittal Letter
☐	$100 Application Fee
☐	Tax Liability Statement
☐	Letters of Support (If Applicable)
☐	Other Appendices (If Applicable)

When the package is completed, send an electronic version to Ms. Karlene Fine at kfine@nd.gov, and 2 hard copies by mail to:

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840

For more information on the application process please visit:
http://www.nd.gov/ndic/renew/info/submit-grant-app.pdf

Questions can be addressed to Ms. Fine at 328-3722, or Andrea Holl Pfennig at 328-2687.

Renewable Energy Program

North Dakota Industrial Commission

Application

Project Title: Biobased Non-isocyanate Urethane Hybrid Resins for Pultrusion Composites

Applicant: North Dakota State University, Tecton Products

Principal Investigators: Zhigang Chen, Dennis Wiesenborn, Chad Ulven, Neena Ravindran

Date of Application: 12-30-2010

Amount of Request: $200,000

Total Amount of Proposed Project: $400,000

Duration of Project: 2 years

Point of Contact (POC): Zhigang Chen

POC Telephone: 701-231-5329

POC Email: zhigang.chen@ndsu.edu

POC Address: Center for Nanoscale Science and Engineering, North Dakota State University, ND58102

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Please use this table to fill in the correct corresponding page number.

ABSTRACT

Objective:

North Dakota State University and Tecton Products (Tecton) are collaborating to develop bio-based composites manufactured with the pultrusion process in Fargo, ND, using the abundant renewable resources available in North Dakota. This project will specifically bring this novel idea from concept to the prototype product stage by accomplishing the following objectives:

1. Synthesis, characterization and scale-up of hybrid urethane-polyester resins through green, non-isocyanate routes using the abundant renewable materials available in North Dakota derived from soybean, canola, corn and sugar beet.
2. Characterization of the hybrid urethane-polyester resin and fine-tuning of the formulation to make it suitable for use in the pultrusion process.
3. Fabricate and test prototype pultrusion hybrid urethane-polyester composites.

Expected Results:

The expected results include the establishment of baseline knowledge for the novel bio-based urethane-polyester resin technology for Tecton's pultrusion composite applications; conversion of the bio-based resin technology to the prototype stage in Tecton's manufacturing process; promotion of the demand and value of North Dakota renewable materials; and create a plan for the commercialization of the novel resin and raw materials developed in this project.

Duration:

The duration of this project is estimated at 2 years.

Total Project Cost:

The total project cost is budgeted at $400,000.

Participants:

This project will be a collaboration between North Dakota State University and Tecton Products, LLC.

PROJECT DESCRIPTION

Planned Activities:

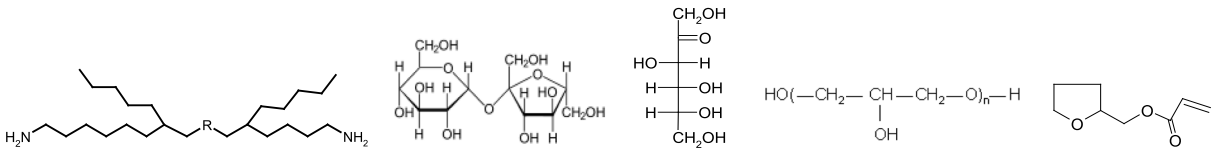
In order to meet the objectives stated on the abstract, North Dakota State University (NDSU) and Tecton Products, LLC (Tecton) will perform the following specific activities:

1. Lab scale synthesis and characterization of hybrid urethane-polyester resins through green, non-isocyanate routes using North Dakota abundant renewable materials derived from soybean, canola, corn and sugar beets.
2. Lab-scale resin curing, composite fabrication and characterization at NDSU and Tecton.
3. NDSU pilot plant resin scale-up and characterization.
4. Pultrusion process trials of a prototype profile/component with the hybrid polyurethane resin at Tecton. Develop a good understanding of the manufacturability using the hybrid resin.
5. Test prototypes to validate physical properties of the resulting composite at NDSU and Tecton.

Methodology:

The economic, environmental, and political concerns regarding national petroleum usage has driven an increased interest in bio-based fuels and other bio-products. The U.S. National Research Council's Committee on Bio-based Industrial Products, Board on Biology, and Commission on Life Sciences have marked the area of bio-based plastics and composites development as one of their research priorities for the nation to combat the dependence of petroleum-based products (NRC, 2000). Industry and academic leaders on the Biomass Research and Development Technical Advisory Committee established a goal of increasing use of bio-based chemicals and materials from 5% of the 2002 market to 25% (55.3 billion pounds) by 2030 (BRDTAC, 2002 & 2006).

Intensive research and development of bio-renewable materials is in urgent need in order to replace current petroleum based materials used in a wide variety of applications such as polymers, composites, coatings and adhesives. North Dakota is rich with bio-renewable resources that have great potential in higher value-added industrial utilizations. For example, Figure 1 shows some bio-based chemicals useful as building blocks for polymer materials. They are all derived from ND abundant agricultural products such as vegetable oils, sugar beets and corn etc.



C36 fatty diamine *Sucrose* *Fructose* *Polyglycerol* *THFA*

Figure 1. Examples of bio-based building blocks.

Polymer composites are polymeric resins reinforced by fillers including fiberglass mats, woven fiberglass, etc. They are widely used in a variety of domestic applications, including window and door framing, decking, and ladders. Several classes of polymeric resins are commonly used such as unsaturated polyesters, epoxies and polyurethane resins (PURs). One of the techniques for making composites is through the pultrusion process which is a continuous processing technique for cost-effectively manufacturing profiled shapes in large volumes. Tecton is interested in developing products based on PU resins. PU resin based pultrusions have a flexural strength that is typically two times greater than polyester and this is desirable in structural applications. In addition, the ductility and strength of PURs eliminate the need for transverse mat reinforcements which is desirable from a processing perspective. A typical polyurethane pultrusion composite product is made by reacting a two-pack system containing the isocyanate and polyol in a heated die, while the rovings are pulled through the process. Disadvantages of such a process are the humidity sensitivity and strict metering requirements. In addition, toxicity and sensitization concerns are well-known for isocyanates. The excellent properties of PURs are attributed to the hydrogen bonding originating from the urethane bonds. Currently thermoset PUR are used in many processes and isocyanate can be handled through engineering controls, i.e. ventilation. A thermoset PUR system **without** isocyanates would be preferred from the safety and environment standpoint. Unsaturated polyester resins (UPEs) are most commonly used in pultrusion composites; and they are cured through a free radical initiator triggered polymerization process. This curing mechanism is robust in terms of low environment sensitivity and low metering requirements. However, further enhancements in mechanical properties can be expected by switching to an alternate chemistry such as PURs. In addition, styrene is used as a reactive diluent in unsaturated polyesters, which brings flammability and VOC (volatile organic compounds) concerns.

Our goal is to make hybrid urethane-polyester resins through green, non-isocyanate routes for prototype pultrusion composite fabrication at Tecton. The following activities will be conducted to accomplish our proposed objectives:

1. **Lab-scale resin synthesis and characterization:** Two groups of bio-based hybrid PU resins will be synthesized, one is linear oligomers, and the other is multi-functional oligomers. The specific chemistry of making the proposed resins is described in Appendix A. NDSU will work closely with Tecton to determine the best resin chemistry. The building blocks for these oligomers are mostly commercial bio-based materials including soy biodiesel, fatty diamine/diacids/diols from vegetable oils, sucrose, fructose, and polyglycerol. Common petro-based building blocks will also be used when needed including maleic anhydride, phthalic anhydride, propanol amine and xylene diamine etc. These building blocks will facilitate the synthesis chemistry, and provide necessary structures in the end product backbone for enhanced materials properties. Characterization techniques such as FTIR, NMR, GC-MS, MS, GPC etc. will be used to fully characterize the resins.
2. **Lab-scale resin curing, composite fabrication and characterization:** Formulated resin matrix composed of initiator package provided by Tecton, linear and multi-functional oligomers, and reactive diluents will be made. Instead of styrene, tetrahydrofurfural acrylate (THFA) will be used as the main reactive diluent. Tetrahydrofurfural is a bio-based material derived from agricultural waste such as corn cobs, oat, wheat bran, and sawdust. It has 60% bio-content and good diluent properties. As shown in Figure 1, THFA has a relative rigid ring structure. It is expected that using THFA as the reactive diluent will impart balanced properties to the composites as well as eliminate the VOC – styrene in the composite formulation. NDSU and Tecton will optimize the curing conditions including initiator and temperature. Lab-scale composites will be made using liquid molding techniques (hand lay-up and/or compression molding) in order to test smaller quantities of resin which will be produced initially before larger batches for prototyping at Tecton. Composite tensile and flexural mechanical properties will be obtained according to ASTM standards D638 and D790, respectively. Influence of the hybrid urethane-polyester resins and synthetic fibers on strength, elasticity, and toughness will be analyzed. Dynamic mechanical analysis of the composites will be performed using a TA Instruments Q800 DMA to determine the viscoelastic properties of the bio-composites developed. At this stage Tecton will provide the specifications for the resin system being developed and the benchmark for expected performance properties for the finished product, as well as the evaluation criteria for qualifying the new material.
3. **Scale-up trial resins:** Once the resin with the most attributes for success is identified, NDSU will proceed to scaled-up synthesis, which will be carried out at the NDSU Pilot Plant. The identified

resin will be synthesized from commercially available intermediates, and the synthesis conditions of temperature, time, mixing and reactant and catalyst ratios will adhere to the bench-scale process as closely as possible. Resin viscosity will be determined using standard methods. Other methods of analysis will be developed, as needed, to ensure consistent resin quality.

4. **Fabricate prototype pultrusion hybrid polyurethane composite at Tecton, study the manufacturability of the hybrid polyurethane composite:** Tecton will conduct lab-scale experiments involving differential scanning calorimetry and SPI gel testing on the promising resin system to determine the conditions for manufacturing pultrudable parts. Further experimentation will be conducted to develop mixes and guidelines on what to expect especially with respect to temperatures on the pultrusion line. Evaluation of die design for suitability to the new resin system will also be conducted. Die modifications or even the use of an alternative die used for pultrusion of PURs will be carried out, if required. After ascertaining that the resin system is ready for a plant trial, Tecton personnel from R&D, product development, process support and coating team will translate the resin into a pultrudable product.
5. **Test and validate physical properties of prototypes pultrusion composites:** Testing will be performed in order to assess the strength of the pultruded parts against the criteria for the specific high strength applications. This testing will be conducted either with the resources available at Tecton or at independent test facilities specializing in such strength testing. Additional testing at NDSU and outside laboratories will be used to evaluate other pultrusion properties performance. Specifically, the USDA microscopy laboratory facility will be used to evaluate various characteristics of the pultrusion, as well as the Center for Nanoscale Science and Engineering (CNSE). Outside test laboratories will be contracted to complete additional qualification testing required per Tecton's material testing protocols. Tecton will then select a profile/shape to prototype for testing. If the lab work performed on the resin system prior to trial identifies the need for processing changes, the shape may require further adjustment to run with these changes. In addition, if the resin system results in a difference in shrinkage after cure, other processing parameters may be adjusted.

Anticipated Results:

Tecton will require the resin for lab-scale evaluation (~1 lb) to determine processing parameters and for plant trials (up to 50 lbs). Multiple formulations might need to be evaluated in the plant to produce an acceptable prototype meeting the specifications as laid out during the initial phase of the project. Multiple trial runs may be needed, in order to adjust/optimize the pultrusion processes to the new resin system. Thus the goal of synthesis scale-up is to produce up to 50 pounds of resin, and to have in place the capacity to produce additional 50-pound batches in the future. Our goal is that the final synthesized resin will have approximately 40-60% bio-based content. In addition, we are anticipating that the new resin system can be incorporated into current Tecton pultrusion processes without major modifications. We also anticipate that the new composite will exceed the physical properties of a UPE composite product, with respect to flexural modulus, water absorption and impact resistance.

Facilities

NDSU is equipped with sufficient instruments and facilities through the Center for Nanoscale Science and Engineering (CNSE), the Mechanical Engineering (ME) and Agriculture and Biosystem Engineering (ABEN) departments for lab-scale resins and composites synthesis and characterization. Lab-scale urethane-polyester hybrid resin synthesis and characterization facilities and instruments are located at and conveniently accessible in the two neighboring buildings of Department of Coatings and Polymeric Materials and CNSE. Mechanical Engineering has a full suite of composite testing equipment in house. The NDSU Pilot Plant was funded by the State of North Dakota specifically to scale-up processes such as this which add value to North Dakota commodities. This is a highly functional facility with process steam, compressed air, vacuum, softened and distilled water, and electrical hook ups, as well as process tanks, mixers, pumps, heat exchangers and a quality control lab. The scaled-up resin will then be used in Tecton's manufacturing facilities in Fargo for both lab and plant-scale trials. Tecton's testing capabilities include mechanical property (tensile, flexural, etc.) testing instruments; specialized measurement tools such as profile dimensional scanner and CMM; engineering capabilities such as 3D modeling with structural/thermal finite element analysis and in-house engineering and tool and die departments; and a rapid prototype equipment that converts 3D designs to actual parts. These capabilities will be utilized to fabricate the bio-based pultrusion composite.

Resources:

The resin synthesis, scale-up, and composite characterization expertise at NDSU and the composite production expertise at Tecton will ensure the smooth progression of the project. In addition, many

bright talented students with fresh perspectives and ideas will contribute greatly to the vision set forth by the principle investigators and will act as the conduit for technology transfer between the different departments on campus and with Tecton.

Techniques to Be Used, Their Availability and Capability:

CNSE has been successfully conducting renewable materials-based resins synthesis and application projects for United Soybean Board and North Dakota Soybean Council for the past 3 years. Some of the synthesis chemistry proposed is being practiced at CNSE in ongoing projects. Established resin scale-up and composite testing expertise and facilities at NDSU ME and ABEN will be used. Tecton has all the necessary techniques to fabricate and test the prototype composite.

Environmental and Economic Impacts while Project is Underway:

No negative environmental impacts are foreseeable during the project. The use of non-isocyanate routes to produce hybrid UPE-PURs will significantly reduce the environmental and safety concern. Green chemistry principles such as use of bio-based raw materials, non-toxic catalyst, and solvent-free synthesis will be implemented wherever possible in the synthesis and production of the prototype bio-based composites. All chemical waste produced in NDSU labs will be disposed according to established protocols. Research staff at CNSE, a regionally prestigious contract research institute, will be hired to conduct the resin synthesis task, thus creating jobs locally. From Tecton's perspective, utilization of green chemistry will support the energy-efficient initiatives and marketing. This can also positively impact compliance with VOC regulations applicable to Tecton.

Ultimate Technological and Economic Impacts:

The proposed novel hybrid resin technology combines both the advantages of the polyurethane materials and unsaturated polyesters. The pultruded bio-based composites based on this resin technology will have significant bio-renewable content, good performance and potentially lower cost. In addition, the fabrication and use of such products conform to the latest government environment regulations, thus they are expected to receive wide market acceptance. Ultimately these North Dakota produced, nationally distributed, bio-based composites will contribute significantly to a sustainable regional economy by job creation at both NDSU and Tecton. The proposed research will promote the utilization of ND based, low cost, bio-renewable resources. Thus, the North Dakota Soybean Council has

pledged $80,000 in matching funds, and the North Dakota Corn Utilization Council and Northern Canola Growers have contributed letters supporting this proposal (appendix)

Why the Project is Needed:

The ultimate environmental and economic outcome from the proposed bio-based hybrid resins and composites is significant. Bio-based chemicals derived from abundant North Dakota agricultural products will be used as building blocks, creating value and demand for North Dakota agricultural products. In the foreseeable future, "green" bio-based materials will receive wide acceptance as a result of stricter environmental regulations, rising environmental sense in the community, and "green" initiatives from the government such as the "Green Building" program from EPA, USDA BioPreferred Program, and the LEEDS (Leadership in Energy and Environmental Design) program. The proposed bio-based hybrid resins are expected to bring both economic and environmental benefits to North Dakota farmers, local businesses and the society. This research will also promote the propagation of research in the area of bio-based technology and its use.

STANDARDS OF SUCCESS

Deliverables: 1. A report and a patent(s) describing the synthesis of the urethane-polyester hybrid resins; 2. A report and a patent(s) describing the use of above hybrid resins to make prototype pultrusion composites; 3. Prototype pultrusion composites made at Tecton. As a result of the project, North Dakota abundant bio-based raw materials will be used in high-value added, "green" industry products produced locally. "Green" research and manufacturing jobs will also be created as the outcome of this project.

BACKGROUND/QUALIFICIATIONS

Lead investigator for resin synthesis and characterization: Dr. Zhigang Chen. He is a senior research scientist at CNSE. He has been a principle investigator/co-principle investigator for multiple biorenewable materials industrial utilization projects funded by United Soybean Board and ND Soybean Council for the past three years, with total funding over $600K. He has rich experience in synthesizing new bio-based materials. He obtained his PhD in NDSU Dept. of Coatings and Polymeric Materials, and has five years industry coatings and adhesives product development experience as a development chemist. His expertise is in resin synthesis and their application in industry products such as coatings,

polymers and composites. He will coordinate the research activities led by other lead investigators for individual objectives, and organize interim progress reports.

Lead investigator for lab-scale resin curing study and composite fabrication and test: Dr. Chad Ulven. Dr. Ulven and his research group have been working on biocomposite materials reinforced with short and long cellulose fibers over the past five years. Utilization of biobased short cellulose fibers from corn, sunflower, and sugar beet processing have been shown to enhance the value of agricultural byproducts while reducing petroleum needs. Studies based on long cellulose fibers have been focused on surface treatments of bast natural fibers such as flax, hemp, kenaf, etc. and their affects on multiple physical properties, processability, and environmental impact. Large gains in ease of composite processing and physical property manipulation has been demonstrated by utilizing low-cost, low environmental impact fiber surface treatments in combination with resin modifications developed. Several of the biocomposite materials developed have been implemented and demonstrated in industrial applications with partners such as the Composites Innovation Centre (Winnipeg, MB, Canada), SpaceAge Synthetics, Inc. (Fargo, ND, USA), John Deere Co. (Moline, IL, USA), Steinwall, Inc. (Coon Rapids, MN, USA), and AGCO Corp. (Jackson, MN, USA).

Lead investigator for resin scale-up: Dennis Wiesenborn (Ph.D. Chemical Engineering, Rice U.) has conducted process engineering research and teaching at NDSU since 1989 related to processing of agricultural commodities. Current, externally funded projects include vegetable oil-based resins for use in composite materials, evaluation of new canola varieties for biodiesel performance and processing and storage of raw juice from energy beets for use as an ethanol feedstock.

Lead investigator for prototype pultrusion hybrid polyurethane composite fabrication and testing at Tecton: Dr. Neena Ravindran. She is the R&D Project Manager at Tecton Products. Her areas of expertise include polymer synthesis, polymer nanocomposites, coating formulations and pultruded composites. She has a PhD from the NDSU Dept. of Coatings and Polymeric Materials, and has industrial experience in paint manufacturing and applications research and development and academic experience in the area anti-corrosive primers among others. She will lead the task related to the development of prototype pultruded hybrid polyurethane composite.

MANAGEMENT

The Lead Investigators for each activity will work closely and communicate at any time during the project. They will also meet monthly to communicate the development progress. In addition, the team will utilize Tecton's Advanced Research project management processes to track progress with respect to established milestones, project scope and budget.

TIMETABLE

The project will proceed according to the timetable shown below. Half year and year-end reports will be submitted to the NDREP and NDSC.

ID	Task	Duration	Start	Finish
1	Resin sythesis and characterization	13 mons	Mon 7/4/11	Sat 6/30/12
2	Study of resin cure	127 days	Thu 1/5/12	Sat 6/30/12
3	Testing of composite properties	131 days	Fri 12/30/11	Sat 6/30/12
4	Selection of optimal chemistry, resin synthesis optimization and scale-up	261 days	Fri 6/29/12	Sun 6/30/13
5	Preparation of composite prototype at Tecton	130 days	Mon 12/31/12	Sun 6/30/13

BUDGET

Project Associated Expense	NDREP	NDIC's Share	Applicant's Share (Cash)	Applicant's Share (In-Kind)	Other Project Sponsor's Share
Budget requested	NDREP		Tecton	Tecton	ND Soybean Council (Pending)
Salaries					
Research Scientist	31,052				
Doctoral Research Personnel	12,953				
Research and Development Personnel	20,874				
Graduate Student	19,850				
Undergraduate Student	6,933				
Other Personnel Direct Support	4,833				
Fringe Benefits	32,030				

Materials & Supplies	8,638,				
Fees and Services	7,576				
F&A	55,261				
Total Requested	**$200,000**				
Total Matching	**$200,000**		20,000	100,000	$80,000
Total Project Cost	**$400,000**				

Lab-scale resin synthesis and characterization, to be conducted by NDSU CNSE: Year 1 Budget. Total requested from NDREP is $60K for Year 1. This includes 2 months of salary for a research scientist and 3 months salary for a research specialist, a small amount for other direct support. Fringe benefits are calculated 47.5% for CNSE full-time staff. Additional costs include $3,000 for materials and $3,686 for fees including $3,104 for service center tool fees and $582 to cover the cost of phones, supplies, IT, and copies. CNSE's F&A rate is 35% of the total direct costs. Additionally $80K pending from ND Soybean Council (used to support CNSE, ME and ABSE activities in Year 1, detail break-down is shown in Appendix B), and $19,280 in-kind from Tecton will be used as matching. The total requested for year 2 is $140K from NDREP. The budget for CNSE includes 2 months salary for a research scientist, 3.5 months for a research specialist and a small amount for other direct support. Additionally, $2K in supplies and $3,890 in fees as described above. Tecton's match for year 2 is $80,880 in-kind, and $20K cash match will be used over 2 years to cover prototype development related tests. Additional funds for year 2 will be used for work to be completed as described below by the NDSU ME and ASBE departments.

Lab-scale resin curing, composite fabrication and characterization, to be conducted by NDSU ME: $30K from NDREP for Year 2 will be used to conduct this portion of the research project. This will include support of 1 graduate student over the project duration. Graduate students in the Mechanical Engineering Department are provided a research assistantship stipend of $1650/month plus 2% fringe benefits. Materials and supplies are budgeted at $514. F&A rate for Mechanical Engineering department is 44.5% of total direct costs of $20,761.

NDSU pilot plant resin scale-up – to be conducted by NDSU ABSE: Year 2 requested from NDREP is $40K. Salary $12,953 will cover 50% of 5-months salary for a postdoctoral researcher; plus fringe benefits of 35%; one undergraduate student for 8 months total $6,933 plus 2% fringe benefits. Supplies of $3,124 will cover glassware, materials and equipment to scale up the production of the resin (mixer, steel vessels). F& A rate of 44.5% will apply to total direct costs of $27,682 for the ABSE department.

The total match of $200,000 has been committed from the following sources, should NDREP fully fund this request: ND Soybean Council $80,000, $100,000 in-kind match with an additional $20,000 of cash from Tecton. *If less funding is available than that requested, the match from the partners may be reduced and the project's objectives will be delayed. In this case, limited resin formulations will be made and evaluated in order to prove the concept.*

CONFIDENTIAL INFORMATION

This proposal does not contain any confidential information.

PATENTS/RIGHTS TO TECHNICAL DATA

NDSU and Tecton reserve the right to all intellectual property developed as part of this project.

List of Appendices

A - The synthesis of biorenewable urethane-polyester hybrid resins

B – NDSC $80,000 award letter, and budget break-down for $80,000 from NDSC.

C – Email communication from Tecton showing the commitment of $100,000 in-kind and $20,000 cash match; budget for Tecton's in-kind and cash match

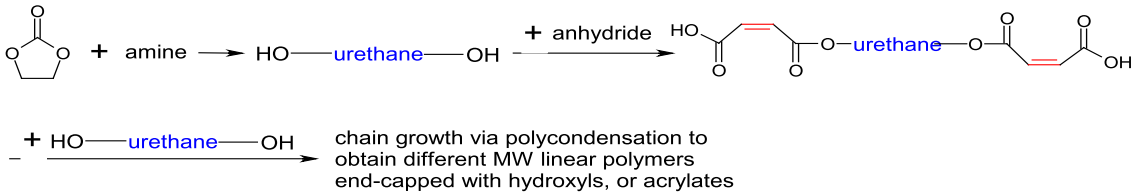
D – Budget form showing the distribution of NDREP funding within NDSU departments for Year 1 and 2.

Appendices

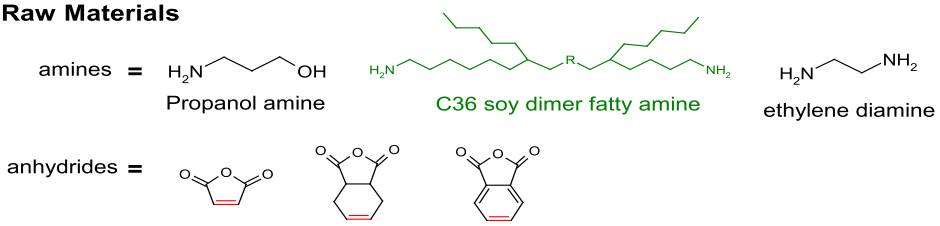
A: The synthesis of biorenewable urethane-polyester hybrid resins

1: Synthesis of linear urethane-polyester hybrid oligomers with 2 different routes:

Route 1

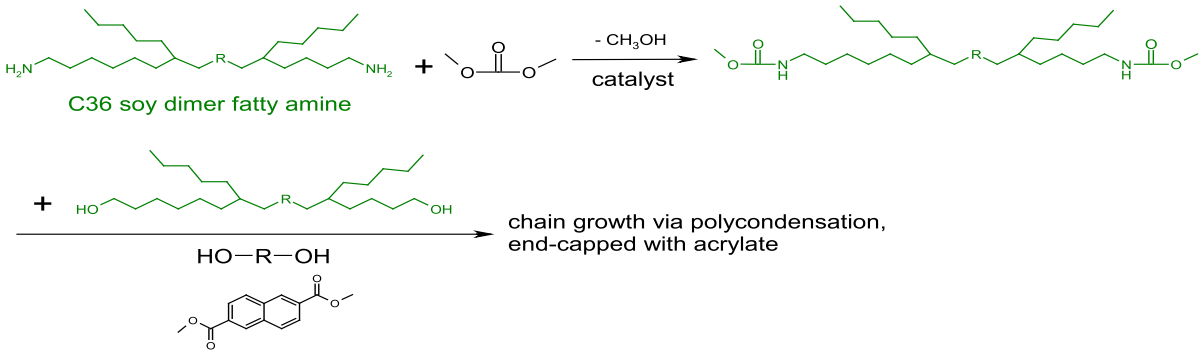


Raw Materials



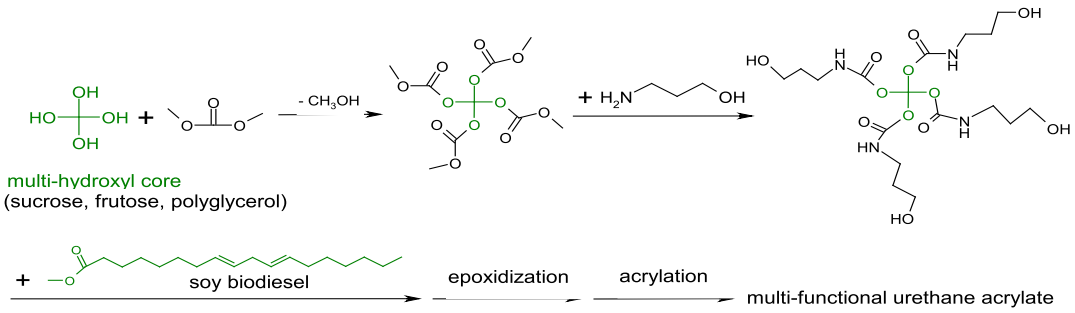
In this route, either hydroxyl or acrylate terminated urethane polyesters will be produced with various molecular weights. A blend of maleic anhydride and ring containing anhydrides will provide hardness and unsaturation points for free radical curing, in addition to the acrylates.

Route 2



With this route the methyl carbamate terminated fatty dimer amine will first be produced using dimethyl carbonate (a green reactive solvent) chemistry. Then, through the transesterification with soy fatty diol, or shorter chain petro-based diols or dimethyl 2,6-naphthalene dicarboxylate, urethane polyesters will be produced. End-capping the terminal hydroxyls of these oligomers with acrylates will impart curing functional groups.

Task 2. Synthesize multi-functional hybrid PU oligomers according to the scheme shown below. These multi-functional oligomers will provide higher crosslink density to the composite materials.



Here the low cost biobased multi-hydroxy functional cores will first be end-capped by dimethyl carbonate, further reaction with amino alcohols will generate multi-arm urethane polyols, the following transesterification and functionalization reaction using soy biodiesel will produce multi-functional soy-based urethane acrylates for free radical curing.

Appendix B

	NDSU ABSE	NDSU ME	NDSU CNSE
	$ 80K from NDSC for July 1st 2011- June 30th 2012		
Salary			
Post-doctoral researcher	12,188	-	10,130
Research specialist	-	-	9,125
Other Personnel Direct Support	-	-	2,603
Graduate student	-	16,500	-
Fringe benefits	3,766	330	10,383
Service center fees/equipment fees	-	1,170	4,000
Materials and supplies	4,046	2,000	3,759
Total from NDSC ($)	20,000	20,000	40,000
Budget justification	Salary will cover 50% of 5 month salary of a Postdoc, fringe benefits is 30.9% of the salary, supplies covers glassware, reactants, and equipments to scale up the production of the resin (mixer, steel vessels)	Salary will cover 10 months of graduate student research assistant (GRA) support at $1,650 per month; Fringe benefits are charged at 2% of the GRA's base salary; Materials & supplies include metal for fixtures, molds, lab consumables, reinforcing fabric, etc.; Equipment fees covers the use of load frames, thermal-mechanical apparatus, etc. charged by an hourly rate	Salary will cover 3 months for a post doc research scientist and a research specialist. Additionally a small amount will cover other direct support personnel. Fringe benefits are calculated at 47.5% for all CNSE full-time staff. Materials will cover lab supplies and fees and services include fees for the use of service center tools.

North Dakota Soybean Council
Our World Is Growing.

1411 32nd St S Ste 3 • Fargo, ND 58103-6304 • Tel: 701.239.7194
Free: 888.469.6409 • Fax: 701.239.7195 • www.ndsoybean.org

CORRECTION TO 12/7/2010 LETTER

December 8, 2010

Zhigang Chen/Dennis Wiesenborn/Chad Ulven
Department of Ag & Biosystems Engineering
NDSU Department 7620
P.O. Box 6050
Fargo, ND 58108-6050

Dear Gentlemen:

The ND Soybean Council met on December 2, 2010 and approved funding for your grant "Biobased Non-isocyanate Urethane Hybrid Resins for Pultrusion Composites" for a total of **$80,000**. The first 25% payment for your grant will be processed immediately following July 1, 2011. The term of your grant is July 1, 2011-June 30, 2012. **These dollars are contingent on your project receiving matching funds of $200,000 from NDREP and $20,000 from Techton Products and no soybean check off dollars being used for IT services or phone services (overhead).**

Gentlemen, we are pleased to see your dedication to the soybean commodity and we will look forward to working with you in the months ahead.

Regards,

Deborah Johnson, Executive Director

Distribution	In-kind match											Cash match
Time Frame	Personnel time (hrs)	Department	Rate ($/hr)	Cost	Protyping cost	Rate	Line time (estimated on running strip die/cost could be higher)	Rate ($/hr)	Cost	Tooling cost	Rate	(Distributed over 2 years)
Year 1	384	R&D	45	17280								
Year 1	40	Product Development	30	1200								
year 1	20	Process Support	40	800								
Year 2	384	R&D	45	17280			30	1000	30000	25000		
Year 2	40	Product Development	30	1200	5000							
Year 2	50	Process Support & T&D	40	2000								
Total	918	0	230	39760	5000		30	1000	30000	**$25,000**		20000

	Inkind match	Cash match
Total sum	101938	20000
Tecton contribution	**121938**	

Allocation of resources	Function/ Task	Activity or how time was estimated	Hours
Year 1	R&D	2 days a week for 6 months	384
Year 1	Product Development	Lab scale testing efforts	40
Year 1	Process Support	Transition of lab product to a pultrudable product	20
Year 2	R&D	Plant trials and scale up activities (over a year)	384
Year 2	Product Development	Prototype activities	40
Year 2	Process Support	Plant trials	50
Year 2	Prototyping cost		
Year 2	Tool and die		

From:	Robert Plagemann
To:	Chen, Zhigang
Cc:	Neena Ravindran
Subject:	Tecton"s Contribution to the Project
Date:	Thursday, December 23, 2010 10:14:58 AM

Chen-

The purpose of this e-mail is document Tecton's commitment to $100,000 in-kind and $20,000 cash contribution for the Biobased Non-isocyanate Urethane Hybrid Resins for Pultrusion Composites Project over a period of two years. If you have any questions, please feel free to call me.

Sincerely,

Robb

Robert P. Plagemann
Director of Product and Process Development
Tecton Products - Fargo
4401 15th Ave NW
PO Box 2712
Fargo, ND 58108-2712
Ph: (701) 277-5442
Fx: (701) 277-0219
E-Mail: rplagemann@tectonproducts.com
www.tectonproducts.com

COOPERATIVE AGREEMENT BUDGET SUMMARY

TITLE

Biobased Non-isocyanate Urethane Hybrid Resins for Pultrusion Composites

ORGANIZATION

North Dakota State University, Center for Nanoscale Science and Engineering, Fargo

PERIOD OF PERFORMANCE

07/01/2011 to 06/30/2013

PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR

Zhigang Chen

	Total Requested from NDREP	YR 1	Yr 2
A. SENIOR PERSONNEL			
1. Research Scientist	31,052	12,802	18,250
2.	-	-	-
3.	-	-	-
4.	-	-	-
TOTAL SENIOR PERSONNEL	31,052	12,802	18,250
B. ADDITIONAL LABOR	-		-
1. Doctoral Research Personnel	12,953	-	12,953
2. Research/Development Professionals	20,874	10,437	10,437
3. Graduate Students	19,850	-	19,850
4. Undergraduate Students	6,933	-	6,933
5. Other Personnel Direct Support	4,833	2,360	2,473
TOTAL SALARIES AND WAGES (A+B)	96,495	25,599	70,896
C. Fringe Benefits *47.5% CNSE F-T; UGRA 5.83%; GRA 2%, Post-Doc 35%*	32,030	12,160	19,870
TOTAL SALARIES, WAGES, AND FRINGE BENEFITS (A+B+C)	128,525	37,759	90,766
D. TRAVEL 1. Domestic	-	-	-
2. Foreign	-	-	-
TOTAL TRAVEL	-		-
E. OTHER DIRECT COSTS	-	-	-
1. Materials and Supplies	-		-
2. Minor Equipment	8,638	3,000	5,638
3. Repairs and Maintenance	-	-	-
4. Fees and Services	-	-	-
5. Subcontracts/Subawards Number of Subcontracts/Subawards	7,576	3,686	3,890
TOTAL OTHER DIRECT COSTS	-	-	-
F. CAPITALIZED EQUIPMENT (> $5,000)	16,214	6,686	9,528
	-		-
TOTAL CAPITALIZED EQUIPMENT	-		-
	-	-	-
TOTAL DIRECT COSTS *(A THROUGH F)*	144,739	44,445	100,294
G. INDIRECT COSTS. CNSE 35%; ABSE & ME 44.6% of Total Direct Costs	55,261	15,555	39,706
H. TOTAL DIRECT AND INDIRECT COSTS (F+G)	200,000	60,000	140,000
I. Matching funds ND Soybean Council (Pending)	80,000	80,000	
Matching funds Tecton ($100K In-Kind) + $20K In Cash Expenditures	120,000	40,000	80,000
J. TOTAL COST OF PROJECT	400,000	180,000	220,000

PI/PD NAME Zhigang Chen DATE

INST. REP. NAME Amy Scott, Asst. Director, Sponsored Programs Admin. DATE

Amy B. Scott 12-30-10

COOPERATIVE AGREEMENT BUDGET SUMMARY YEAR 1

TITLE

Biobased Non-Isocyanate Urethane Hybrid Resins for Pultrusion Composites

ORGANIZATION

North Dakota State University, Center for Nanoscale Science and Engineering, Fargo

PERIOD OF PERFORMANCE

07/01/2011 to 06/30/2013

PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR

Zhigang Chen

	CNSE Hours	CNSE TOTAL Year 1
A. SENIOR PERSONNEL		
1. Research Scientist	302	$12,802
2.	-	$0
3.	-	$0
4.	-	$0
TOTAL SENIOR PERSONNEL	302	$12,802
B. ADDITIONAL LABOR		
1. Doctoral Research Personnel		$0
2. Research/Development Professionals	525	$10,437
3. Graduate Students	-	$0
4. Undergraduate Students	-	$0
5. Other Personnel Direct Support	83	$2,360
TOTAL SALARIES AND WAGES (A+B)	910	$25,599
C. Fringe Benefits *47.5% CNSE F-T; UGRA 5.83%; GRA 2%*		$12,160
TOTAL SALARIES, WAGES, AND FRINGE BENEFITS (A+B+C)		$37,759
D. TRAVEL 1. Domestic		$0
2. Foreign		$0
TOTAL TRAVEL		$0
E. OTHER DIRECT COSTS		
1. Materials and Supplies		$3,000
2. Minor Equipment		$0
3. Repairs and Maintenance		$0
4. Fees and Services		$3,686
5. Subcontracts/Subawards Number of Subcontracts/Subawards		$0
TOTAL OTHER DIRECT COSTS		$6,686
F. CAPITALIZED EQUIPMENT (> $5,000)		
TOTAL CAPITALIZED EQUIPMENT		$0
TOTAL DIRECT COSTS *(A THROUGH F)*		$44,445
G. INDIRECT COSTS. *Base = Total Direct Cost - (Cap.Equip.+Subaward amounts up to $25,000); Rate=35%*		$15,555
H. TOTAL DIRECT AND INDIRECT COSTS (F+G)		$60,000
I. RESIDUAL FUNDS (If for further support of current projects) In-kind from TI		
J. TOTAL COST OF PROJECT		$60,000

PI/PD NAME Zhigang Chen	DATE
INST. REP. NAME Amy Scott, Asst. Director, Sponsored Programs Admin.	DATE
Amy B. Scott	12-30-10

COOPERATIVE AGREEMENT BUDGET SUMMARY YEAR 2

TITLE

Biobased Non-Isocyanate Urethane Hybrid Resins for Pultrusion Composites

ORGANIZATION

North Dakota State University, Center for Nanoscale Science and Engineering, Fargo

PERIOD OF PERFORMANCE

07/01/2011 to 06/30/2013

PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR

Zhigang Chen

A. SENIOR PERSONNEL	Hours	CNSE	ABSE	ME	Total From NDREP
1. Research Scientist	410	$18,250			$18,250
2.	-	$0			$0
3.	-	$0			$0
4.	-	$0			$0
TOTAL SENIOR PERSONNEL	410	$18,250			$18,250
B. ADDITIONAL LABOR					$0
1. Doctoral Research Personnel (50% of 5 months)	433	$0	$12,953		$12,953
2. Research/Development Professionals	500	$10,437			$10,437
3. Graduate Students (1 yr)	-	$0		$19,850	$19,850
4. Undergraduate Students (8 mo.)	688	$0	$6,933		$6,933
5. Other Personnel Direct Support	91	$2,473			$2,473
TOTAL SALARIES AND WAGES (A+B)	1,001	$31,160	$19,886	$19,850	$70,896
C. Fringe Benefits *47.5% CNSE F-T; UGRA ABSE 2%; Post-Doc ABSE 35%; GRA 2%*		$14,801	$4,672	$397	$19,870
TOTAL SALARIES, WAGES, AND FRINGE BENEFITS (A+B+C)		$45,961	$24,558	$20,247	$90,766
D. TRAVEL 1. Domestic		$0			$0
2. Foreign		$0			$0
					$0
TOTAL TRAVEL		$0			$0
E. OTHER DIRECT COSTS					$0
1. Materials and Supplies		$2,000	$3,124	$514	$5,638
2. Minor Equipment		$0			$0
3. Repairs and Maintenance		$0			$0
4. Fees and Services		$3,890			$3,890
5. Subcontracts/Subawards Number of Subcontracts/Subawards		$0			$0
TOTAL OTHER DIRECT COSTS		$5,890	$3,124	$514	$9,528
F. CAPITALIZED EQUIPMENT (> $5,000)					$0
					$0
TOTAL CAPITALIZED EQUIPMENT		$0			$0
TOTAL DIRECT COSTS *(A THROUGH F)*		$51,851	$27,682	$20,761	$100,294
G. INDIRECT COSTS. *Rate=35% CNSE; 44.5% ABSE & ME*		$18,149	$12,318	$9,239	$39,706
H. TOTAL DIRECT AND INDIRECT COSTS (F+G)		$70,000	$40,000	$30,000	$140,000
I. RESIDUAL FUNDS (If for further support of current projects)					
J. TOTAL COST OF PROJECT					

PI/PD NAME Zhigang Chen	DATE
INST. REP. NAME Amy Scott, Asst. Director, Sponsored Programs Admin.	DATE 12-30-10

Amy B. Scott