TECHNICAL REVIEWERS' RATING SUMMARY

R011-E

Biobased Non-Isocyanate Urethane Hybrid Resins for Pultrusion Composites

NDSU/Tecton Products
Principal Investigator: Zhigang Chen
Request for $200,000; Total Project Costs $400,000

Rating Category	Weighting Factor	1B	1C	Average Weighted Score
1. Objectives	9	4	4	36.00
2. Achievability	9	3	4	31.50
3. Methodology	7	3	4	24.50
4. Contribution	7	4	3	24.50
5. Awareness	5	2	2	10.00
6. Background	5	3	4	17.50
7. Project Management	2	3	4	7.00
8. Equipment Purchase	2	5	5	10.00
9. Facilities	2	5	4	9.00
10. Budget	2	5	3	8.00
Average Weighted Score		173	183	**178.00**
Maximum Weighted Score				**250.00**

OVERALL RECOMMENDATION

FUND		
FUNDING MAY BE CONSIDERED	x	x
DO NOT FUND		

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Biobased Non-Isocyanate Urethane Hybrid Resins for Pultrusion Composites
Submitted by NDSU/Tecton Products
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1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Renewable Energy Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 1B (Rating: 4)
The technical objectives of the proposed project are clearly articulated in the proposal, with the ultimate goal of new bio-based urethane-polyester resins for pultrusion prosessing. These objectives are consistent with the North Dakota Industrial Commission/Renewable Energy Council goals of promoting development and use of North Dakota's renewable resources and potentially add to the state's agricultural economy.

Reviewer 1C (Rating:4)
The objectives and goals are very clear and highly related to the North Dakota Industrial Commission/Renewable Energy Council goals. A cost analysis objective should also be included.

2. With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

Reviewer 1B (Rating: 3)
The approach is reasonable and potentially achievable, although no preliminary data is provided to indicate that the bio-based resins can be successfully synthesized with properties approaching those of the petroleum based unsaturated polyester resins or urethane resins. I do not see any obvious deficiencies in the proposed chemical synthesis described in Appendix A, but the proposal would be significantly strengthened if some preliminary data were provided showing that the such polymers could be made with adequate thermo-mechanical properties to replace conventional pultrusion resins.

Reviewer 1C (Rating: 4)
The objectives of this proposal are most likely achievable. It would be more convincible if preliminary data were provided in this proposal.

3. The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 1B (Rating: 3)
The goal of making hybrid urethane-polyester resins using bio-based feedstocks and non-isocyanate routes is novel and potentially high impact. The proposal is lacking however in detail about the characterization methods and material property targets for these new materials. Details about glass transition temperature target, initiator candidates considered, and preliminary results to substantiate these targets would indicate a clearer plan for achieving the project goals.

Reviewer 1C (Rating: 4)
The description of the methods is clear. However, experimental design including factor and levels should also be provided.

4. The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Renewable Energy Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 1B (Rating: 4)
The chemistry of the proposed work is creative and has the potential to have a significant scientific/technical contribution. The proposal and its technological impact would be improved if a discussion of the price of the bio-based resins (or the constituent chemicals) were compared with the petroleum-based analogues. The impact of the would be significantly higher if the novel bio-based resins were cost competitive, but no such information is given in the proposal.

Reviewer 1C (Rating: 3)
This proposal will have contribution on the promotion of new technologies for biopolymer production from renewable sources available in ND, but it may not generate immediate renewable energy jobs in ND.

5. The principal investigator's awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 1B (Rating: 2)
Apart from a few National Research Council or Biomass Research and Development Technical Advisory Committee reports, the proposal is completely lacking in references to relevant literature in the area of bio-based polymers, polyurethanes, hybrid urethane-polyesters, etc. In fact, there is no formal reference section in the proposal. References to related chemistries to those shown in Appendix A on the synthesis of the biorenewable urethane-polyester hybrid resins would be particular helpful.

Reviewer 1C (Rating: 2)
This proposal does not have a thoroughly literature review for peer's work in this area from publication, patents and so on.

6. The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 1B (Rating: 3)
Frankly, the background/qualification section of the proposal does not give enough detail to adequately assess the qualifications of the investigators. No information is given about relevant publications or patents by any of the investigators. Dr. Ulven's current position and educational history is not even provided.

Reviewer 1C (Rating: 4)
The team is strong with investigators from both academic institution and industry.

7. The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 1B (Rating: 3)
The project management plan is adequate. The investigators propose monthly meetings among the team leaders and research teams, and a basic timetable is provided. The usefulness of the management plan and of the timetable could be improved by breaking up the five large tasks into appropriate subtasks, so that more detail of the overall project is communicated.

Reviewer 1C (Rating: 4)
The project management plan is very good.

8. The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 1B (Rating: 5)
No equipment to be purchased.

Reviewer 1C (Rating: 5)
No equipment purchase is requested.

9. The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 1B (Rating: 5)
The university appears to have excellent facilities to conduct the research. In addition, the close collaboration with the company partner, Tecton, will allow the research team to use the very unique pultrusion processing facilities.

Reviewer 1C (Rating: 4)
The facilities an equipment available are adequate for the research.

10. The proposed budget "value"[1] relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value. (See below)

Reviewer 1B (Rating: 5)
The budget is very reasonable and the potential return on investment if this proposal were successful is very high. The $80,000 cash matching commitment from the North Dakota Soybean Council and $20,000 cash (plus $100,000 in kind) commitment from Tecton, really make this proposal a good value for the North Dakota Industrial Commission.

Reviewer 1C (Rating: 3)
As the production cost information and preliminary data are not available, it is difficult to judge the success of this project. The matching is 33.3% of the total project cost.

[1] "Value" – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

10a. Financial commitment from other sources – A minimum of 50% of the total project must come from other sources to meet the program guidelines. Higher priority is to be given if the application has private industry investment equal to or at least 50% or more of total cost.

The minimum 50% cash match is demonstrated.

Section C. Overall Comments and Recommendations:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 1B ***(Funding May Be Considered)***
This proposal address an important area for the American Heartland, developing plastics and composites from natural renewable resources, rather than from the petroleum that is currently used for almost all plastics. The investigators approach is novel, and if successful, could have large payoffs economically, environmentally, and energy-wise. However, I have several concerns about the proposal as well. First, the authors propose (in Appendix A) their strategy for developing bio-based hybrid urethane-polyester resins. Such resins may work for pultrusion processing, but the authors have not shown any preliminary data indicating that such chemistries can result in cured networked polymers with the requisite curing and thermo-mechanical properties needed for this demanding composites process. It seems odd that the authors have not synthesized and characterized at least some initial formulations in anticipation of providing such preliminary data for this proposal.

In addition, the proposal would be greatly strengthened if the authors provided a comparison of the anticipated costs for the bio-based resins versus the petroleum based alternatives. If the price difference were too high, I am doubtful that industry would adopt to a new bio-based resin, even if there are "green" incentives to do so.

Finally, the proposal is lacking in sufficient detail about the target properties and characterization tools that the investigators will use to develop the resin formulation that will ultimately be scaled up and evaluated for the pultrusion processing.

Reviewer 1C ***(Funding May Be Considered)***
Merits:
This proposal proposed a new process to produce bio-based non-isocyanate urethane hybrid resins for pultrusion composites from ND based renewable sources. The team is also working closely with ND based industries. The team has the required expertise and facility to conduct the research.

Flaws:
The proposal failed to provide a comprehensive literature review of the related processes and technologies. No preliminary data were provided in the proposal. As the cost of the proposed product is critical for the project success, a comparison cost analysis should be included in the objectives.