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NSF Award Number : 9623595
Title of the Project : CAREER: Fast Net-Shape Manufacturing of Polymer Composite Structures

REFEREED PUBLICATIONS

1. Adanur, S., and Arumugham, Y., "Characteristics of Ultraviolet Cured Glass/Epoxy Textile Composites, Part 2: Results and Discussion", accepted for publication in the Journal of Industrial Textiles, anticipated issue: Volume 32, No. 2, October 2002..
2. Adanur, S., and Arumugham, Y., "Characteristics of Ultraviolet Cured Glass/Epoxy Textile Composites, Part 1: Experimental Procedures and Testing", accepted for publication in the Journal of Industrial Textiles, anticipated issue: Volume 32, No. 2, October 2002.
3. Onal, L., and Adanur, S., "Effect of Stacking Sequence on the Mechanical Properties of Glass-Carbon Hybrid Composites Before and After Impact", Journal of Industrial Textiles, Vol. 31, No. 4, April 2002.
4. Adanur, S., and Onal, L., "Factors Affecting the Mechanical Properties of Laminated Glass/Graphite-Epoxy Hybrid Composites", Journal of Industrial Textiles, Vol. 31, No. 2, October 2001.
5. Liao, T., and Adanur, S., "3D Structural Simulation of Tubular Braided Fabrics for Net-Shape Composites", Textile Research Journal, 70(4), 297-303 (2000).
6. Adanur, S., and Liao, T., "3D Modeling of Textile Composite Preforms", Composites Part B, 29B (1998), 787-793.

OTHER RELATED PUBLICATIONS AND PRESENTATIONS

1. Adanur, S., Mcclain, A., and Xu, B., "A Novel Approach to Fast Net-Shape Manufacturing of Braided Epoxy Composites, Part 1: Curing Characteristics", submitted to Journal of Elastomers and Plastics, June 2002.
2. Adanur, S., Mcclain, A., and Xu, B., "A Novel Approach to Fast Net-Shape Manufacturing of Braided Epoxy Composites, Part 2: Mechanical Properties", submitted to Journal of Elastomers and Plastics, June 2002.
3. Onal, L., and Adanur, S., "Modeling of Macro- and Micro-Mechanical Properties of 2D Woven Fabric Composites – A Review, Part 1: Analytical Models", invited paper submitted to Applied Mechanics Reviews (AMR).
4. Onal, L., and Adanur, S., "Modeling of Macro- and Micro-Mechanical Properties of 2D Woven Fabric Composites – A Review, Part 2: Numerical Solutions", invited paper submitted to Applied Mechanics Reviews (AMR).
5. Adanur, S., and Onal, L., "Experimental Analysis of Textile Composites", Proceedings of the TechTextil North America Symposium, April 2002, Atlanta, GA.
6. Onal, L., and Adanur, S., "Effect of Fiber Content and Stacking Sequence on Low Velocity

Impact Behavior of Glass/Carbon Hybrid Epoxy Composites", ICCE/8, Proceedings of the Eighth Annual International Conference on Compsites Engineering, August 5-11, 2001, Tenerife, Spain.
7. Adanur, S., and Orak, H., "Textile Composites", Technical Presentation, DOE/TACOM Army 21st Century Truck Program, Auburn University, Auburn, AL, 3 August 2000.
8. Adanur, S., "Rotational Curing Device for Fast Net-shape Manufacturing of Braided Composites", Auburn University Technology Disclosure, July 20, 2000.
9. Adanur, S., Xu, B., and Orak, H., "Braided Composite Automotive Chassis Frame", ICCE/7 7th International Conference on Composites Engineering, July 2-8, 2000, Denver, CO.
10. Adanur, S., and Xu, B., "Design and Manufacturing Automotive Chassis Frame with Net-Shape Braided Composite Structures", 2000 NSF Design and Manufacturing Research Conference, January 3-6, 2000, Vancouver, British Columbia, Canada.
11. Adanur, S., and Xu, B., "Fast Net-Shape Manufacturing of Braided Textile Composites", NSF CAREER Awardees Meeting, January 10-12, 1999, Washington D.C.
12. Adanur, S., and Xu, B., "Process Development of Microwave Preheating and Infrared Post Curing of Braided Polymer/Epoxy Composites", The 1999 National Science Foundation (NSF) Design and Manufacturing Grantees Conference, January 5-8, 1999, Long Beach, CA.
13. Adanur, S., and Xu, B., "Characteristics of Microwave-Cured Braided Glass/Epoxy Composites", Composites in Manufacturing, Published by the Composites Manufacturing Association of the Society of Manufacturing Engineers, Third Quarter 1998, Vol. 14, No. 3.
14. Adanur, S., and Xu, B., "Influence of Microwave Fast Preheating on Epoxy Resin Chemorheology Properties", The 1998 International Mechanical Engineering Congress and Exposition, November 15-20, 1998, Anaheim, CA.
15. Adanur, S., and Liao, T., "3D Modeling of Textile Composite Preforms", ICCE/5 Fifth International Conference on Composites Engineering, July 5-11, 1998, Las Vegas, NV.
16. Adanur, S., and Xu, B., "Impact Resistance of Microwave Cured Glass/Epoxy Composites", ICCST/2, 2nd International Conference on Composite Science and Engineering, June 1998, Durban, S. Africa.
17. Adanur, S., "Fabric That Moves", Industrial Fabric Products Rev., IFAI, April 97, pp.46-49.
18. Adanur, S., and Xu, B., "Characteristics of Microwave-Cured Braided Glass/Epoxy Composites", Poster Session, 1998 NSF Design and Manufacturing Grantees Conference", January 5-8, 1998, Monterrey, Mexico.
19. Adanur, S., and Xu, B. , "Characteristics of Microwave-Cured Braided Glass/Epoxy Composites", Composites at Lake Louise, CALL '97, October 12-17, 1997, Canada.
20. Adanur, S., Arumugam, Y. S., and Xu, B., "Fast Net-Shape Manufacturing of Braided Textile Structures", ICCE/4, Fourth International Conference on Composites Engineering, July 6-12, 1997, Big Island of Hawaii.
21. Adanur, S., and Sreekanthreddy, G., "Compression Behavior of 3D Reinforced Glass/Epoxy Laminar Composite Profiles", ICAPC-97, Intern. Conf. on Advanced Polymer Composites, Materials, Processing and Appl., Beijing Univ. of Aeronautics and Astronautics, Beijing, China, June 3-5, 1997.
22. Adanur, S., and Xu, B., "Fast, Net-Shape Manufacturing of Textile Composites", NSF Design and Manufacturing Grantees Conference, Seattle, Washington, Jan. 7-10, 1997.

BRIEF DESCRIPTION OF RESEARCH PRODUCTS

A novel process has been developed and applied in manufacturing of net-shape braided/epoxy composite structures. The novel process developed with NSF funds is a milestone in this area that will impact the design and fabrication of various parts. An on-line impregnator was designed and built on the mandrel, moving back and forth with the braiding machine. Two sets of infrared lamps were placed beside the resin-impregnated mandrel for post curing. The epoxy resin system was first preheated by microwave to quickly reduce viscosity and improve fiber wetting. Then the resin was cast into the impregnator, which has rubber at both ends to prevent the resin from leaking. One of the critical technologies of this novel process was the design and building of a rotational curing center to reduce the influence of gravity on the flow of liquid resins. Figure 1 shows the curing center developed. A patent disclosure has been filed at Auburn University for the impregnator with microwave viscosity reduction that has been developed as a result of this project. As a result of the project's success, this research program has been included in the Transportation Pinnacle, which is one of the 7 Peaks of Excellence areas chosen at Auburn University.

Fig. 1 The novel formation and curing center developed at Auburn University, Department of Textile Engineering

EDUCATIONAL CONTRIBUTIONS

The experimental system developed for this project has been used for undergraduate courses. Some of the manufacturing techniques for building composites have been integrated into several undergraduate courses: ENGR 1110 Introduction to Textile Engineering, TXEN 2250 Fabric Design and Development and TXEN 4250 Advanced Engineered Fibrous Structures. The

experimental system developed with NSF funding is ideal for students to conduct their senior design projects. 18 undergraduate students have done their senior design project work using this system. The results of the project have been disseminated extensively in journals and conferences as listed above.

GRADUATE STUDENTS SUPPORTED

1. Onal, L., "Design and Modeling of 3D Woven/Knitted Hybrid Composite Structures", Ph.D. Dissertation directed by Dr. Sabit Adanur, Auburn University, expected completion date: December 2002.
2. Orak, H., "Characteristics of Braided Composites for Truck Chassis Frame", MS Thesis directed by Dr. Sabit Adanur, Auburn University, Dept. of Textile Eng., August 2001.
3. Xu, B., "Fast Manufacturing of Net-Shape Braided/Epoxy Textile Structural Composites", MS Thesis directed by Dr. Sabit Adanur, Auburn University, Dept. of Textile Eng., August 1999.
4. Arumugham, Y., "Characteristics of Ultraviolet Cured Glass/Epoxy Composites", MS Thesis directed by Dr. Sabit Adanur, Auburn University, Dept. of Textile Eng., December 1998.

Acknowledgement and Disclaimer

This material is based upon work supported by the National Science Foundation under Grant No. 9623595. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.