Anil Netravali

Web Bio

Information

Biography

Biographical Statement

After obtaining Ph.D. from North Carolina State University in 1984 Dr. Netravali joined the Department of Materials Science and Engineering at Cornell University as a postdoctoral associate. In 1985 he joined the Department of Mechanical Engineering as a research associate and in August of 1987 he joined the Department of Fiber Science & Apparel Design as an assistant professor of Fiber Science. His main research is in the field of Fiber Reinforced Composites and Green Materials. Within the composites area the primary focus of his group has been in developing Green resins from plant-based proteins and starches and reinforcing them using plant-based fibers to fabricate environment-friendly, green composites for a variety of applications. In the past few years, his research group has developed green resins and adhesives that have excellent mechanical properties; in some cases, better than commonly used epoxy resins. These carbon-neutral alternatives for the conventional petroleum-based composites are fully compostable at the end of their life. His group has also made ‘Advanced Green Composites’ with high strength and toughness that can be used in primary structural as well as ballistic applications. The second focus of his group is modification of fiber surfaces to control fiber/resin interface characteristics in composites. His research group has used many techniques including polymerizing and non-polymerizing plasmas, pulsed excimer laser, high power ion beam, solvent treatments, etc., to modify fiber surface chemistry and topography and controlling their adhesion to resins and thus the mechanical properties of composites. A third focus of his group is to develop new green nanofibers from proteins and starches for a variety of applications including high efficiency filtration and bacterial nanocellulose from food and agricultural waste for composite and medical applications.

Teaching

Teaching and Advising Statement

I teach FSAD 1350, Fibers, Fabrics and Finishes, alternate years, for freshmen in the department of Fiber Science & Apparel Design. While this course is required for all FSAD students, students from other departments within the College of Human Ecology as well as other colleges across the campus and sometimes outside Cornell (Ithaca College) take the course to fulfill their science requirements. The course introduces the students to various natural and synthetic

fibers, production and properties of yarns and fabrics as well as dyeing and finishing of yarns and fabrics. Teaching this course is always a challenge because of the diverse interests and backgrounds of the students. Students are taught both conventional and new materials, including the green and sustainable materials, conventional fiber applications, latest innovations in the field and new technologies/applications of fibers.

FSAD 1360, Fiber and Yarn Analysis Laboratory, consists of several lab sessions in which students learn techniques to identify and characterize fibers and yarns. This course is restricted to FSAD students only and gives them hands on experience. I teach this course every other year, together with FSAD 1350.

Since Spring of 2014 I have taught FSAD 3320, Product Quality Assessment for FSAD students. This course discusses quality of textile products from fibers to apparel and methods to assess the quality. The course is meant for FSAD junior students.

I also teach FSAD 3350, Fiber Science, at the undergraduate level and FSAD 6200, Physical Properties of Fiber Forming Polymers and Fibers, at the graduate level. FSAD 3350 is designed for our students in the Fiber Science option and is a recommended elective for Materials Science and Engineering (MSE) and Chemical and Biomolecular Engineering (CBE). However, students from other colleges as well as other departments in CHE have also taken this course. FSAD 3350 also has lab sections for characterizing various fiber properties. This course has been useful in attracting MS&E students in Fiber Science program. One MS&E undergraduate student did research in my group in 2014. Several other students have worked in other faculty labs. A few years ago we also launched Fiber Science minor.

FSAD 6200 is a theoretical course that includes properties of polymers and relationship between fiber structure, fiber chemistry and their physical properties. Thermal, mechanical, and other properties of fibers and methods of characterizing them are also discussed. While this course is meant for graduate students in FSAD, students from other colleges, particularly engineering, also take it.

Ongoing teaching goals are to refine and strengthen course contents for all courses while incorporating the latest research into FSAD 6200, FSAD 3350 and FSAD 3320. When possible, I also invite industrial guest lecturers to give students the opportunity to get the industrial perspective. Many times the guest speakers also serve as future contacts for students during their job searches. I also collect and have a large collection of interesting specimens to show in my classes. Students always appreciate the real life examples in the class as it connects the theory to the real life situations.

Professional

Current Professional Activities

Dr. Netravali is a member of the American Chemical Society, the Fiber Society and the American Nano Society. He is an Adjunct Professor at the Universidade Federal do Amazonas (UFAM), Manaus, Brazil, and in the Department of Materials Science & Engineering at Tuskegee University, Tuskegee, AL. He has also been an

International Research Fellow at the Composites Center at Doshisha University, Kyoto, Japan. He serves on the Editorial Advisory Boards of seven research journals; Composites Science and Technology (CST), Journal of Biobased Materials and Bioenergy (JBMB), Journal of Renewable Materials (JRM), Reviews of Adhesion and Adhesives (RAA), Journal of Engineered Fibers and Fabrics (JEFF), Fibers and Textile Research Journal (TRJ). He is a member of the Advisory Committee of the International Workshop on Green Composites, a member of the International Scientific Committee for the Amazonic Green Materials and Processes Meetings as well as a member of the Scientific Committee. He is a Faculty Fellow at the David R. Atkinson Center for a Sustainable Future at Cornell University. He is also a member of the Engineering Panel of the Research Grants Council (RGC) of Hong Kong.

Research

Current Research Activities

Fiber reinforced composites are used in many applications where metals have been commonly used because of their high mechanical properties and much lower density. Most high strength fibers and resins used in 'Advanced Composites' are based on petroleum feedstock, a non-renewable resource that is expected to last 5 to 6 more decades at the current rate of consumption. Further, these composites do not degrade in natural environment. With high production growth due to expanding applications of composites in the past few decades, disposing them off at the end of their intended life has become difficult as well as expensive. Composites, made by combining two dissimilar materials, are difficult to be recycled or reused. While only a small fraction of the composite waste is incinerated to obtain energy or ground into powder for use as low grade filler, most (over 90%) of the composites end up in landfills. Major part of our research is directed towards creating fully sustainable and environment-friendly 'green' resins and composites using yearly renewable plant-based polymers such as proteins and starches and fibers that are considered carbon neutral. At the end of their life green composites can be easily composted to create organic soil which can help grow more plants. Green composites based on plant proteins and starches and fibers developed by our group are suitable for use in packaging, housing or transportation panels, furniture, board sports and secondary structural applications. We have also developed high strength Advanced Green Composites made using liquid crystalline cellulose fibers that have toughness comparable to aramid fiber based composites. These advanced green composites may be used as primary structural elements and even for some ballistic applications.

Second part of our research in the field of composites involves conventional Advanced Composites made using high strength fibers such as graphite, aramids, glass, ultra-high molecular weight polyethylene (UHMWPE), etc., that are used in a wide range of applications from aerospace to sports gear and from automobile body parts to civil structures. Critical mechanical properties of composites such as toughness and longitudinal and transverse strength are controlled by fiber/resin interfacial bonding. My research group is involved in modifying fiber surface topography and chemistry to control their adhesion to different resins. We

have used many techniques including polymerizing and non-polymerizing plasmas, pulsed excimer laser, high power ion beam, solvent treatments and their combinations to obtain desired chemical groups on the fiber surface and modify surface roughness to control the fiber/resin interfacial bonding. We are also working to control resin and fiber/resin interfacial properties using nanoparticles and nanofibrils in resin or fiber surfaces.

Our group has also been involved in creating green nanofibers such as electrospun plant proteins and starches for high efficiency filters. We have also been successful in obtaining bacterial cellulose (BC) nanofibers from food and agricultural wastes for use in applications in medicine and composites.

Current research projects

1. Development of fully biodegradable, environment-friendly ‘green’ composites and nanocomposites using plant based fibers and resins
2. Surface modification of high strength fibers to control their adhesion to various resins including nanophase epoxies
3. Development of bacterial nanocellulose and other ‘green’ nanofibers for high strength composites and other applications
4. Development of ‘green’ seed coatings
5. Development of 'green' treatments for superhydrophobic cotton fabrics

Extension

Current Extension Activities

- I am a member of the Cornell Center for Materials Research (CCMR) and have worked through the center on some of their outreach activities.

- I am also a Faculty Fellow at the Atkinson Center for Sustainable Future (ACSF) and participate in the center activities.

- I have delivered several lectures to different groups at Cornell and within the state of NY on my research in Environment-Friendly Green Materials and their applications.

Education

Education

- Ph.D. - North Carolina State University, Fiber and Polymer Science
- M.S. - North Carolina State University, Fiber and Polymer Science
- M.S. - University of Bombay, Textiles
- B.S. - University of Bombay, Textiles

Courses

Courses Taught

- FSAD 1350 - Fibers, Fabrics and Finishes
- FSAD 1360 - Fiber, Yarn Analysis Laboratory
- FSAD 3320 - Product Quality Assessment
- FSAD 3350 - Fiber Science
- FSAD 4010 - Emirical Research
- FSAD 4020 - Supervised Filedwork
- FSAD 4990 - Undergraduate Research
- FSAD 6200 - Physical Properties of Fiber-forming Polymers and Fibers
- FSAD 8990 - MS Research
- FSAD 9990 - PhD Research

Websites

Related Websites

http://www.human.cornell.edu/che/bio.cfm?netid=ann2

Administration

Administrative Responsibilities

Member, Diversity Committee, 2014

Chair, CIFFI Associate Director Search Committee, 2013-2014

Chair, FSAD Fiber Science Faculty Search Committee, 2014-2015

Member, Graduate Admissions Committee, FSAD

Member, Faculty Advisory Committee, CCMR

Acting Chair - several times

Faculty Advisor, Cornell Badminton Club

Publications

Selected Publications

Rahman, M. M., Netravali, A. N., B. Timob, V. K. Rangari, Bio-derived ‘Green’ composite from soy protein and eggshell nanopowder, ACS Sustainable Chemistry and Engineering, **2 (10)**, pp 2329–2337, 2014 **DOI:** 10.1021/sc5003193

Qiu, K. and Netravali A. N., A Review of Bacterial Cellulose and Bacterial cellulose based Nanocomposites Polymer Reviews, **54 (4),** pp. 598-626, 2014. DOI:10.1080/15583724.2014.896018

Lubasova, D., Netravali, A. N., Parker, J. and Ingel, B., Bacterial Filtration Efficiency of Green Soy Protein based Nanofiber Air Filter, Journal of Nanoscience & Nanotechnology, **1 4**, pp. 4891-4898, 2014.

Vieira, R. K., Vieira, A. K., Kim, J. T. and Netravali, A. N., Characterization of Amazonic White Pitch (*Protium heptaphyllum*) for Potential use as a 'Green' Adhesive, Journal of Adhesion Science & Technology, **28 (10)**, pp. 963-974, 2014. DOI: 10.1080/01694243.2014.880220

Ghosh-Dastidar, T. and Netravali, A. N., Crosslinked Waxy Maize Starch based 'Green' Nanocomposites, Carbohydrate Polymers, ACS Sustainable Chemistry and Engineering, **1 (12),** pp. 1537-1544, 2013. DOI: 10.1021/sc400113a

Kim, J. T. and Netravali, A. N., Fabrication of Advanced 'Green' Composites using Potassium Hydroxide (KOH) Treated Liquid Crystalline (LC) Cellulose Fibers, J. Materials Science**, 48,** pp. 3950-3957, 2013. DOI 10.1007/s10853-013-7199-7

Qiu, K. and Netravali, A. N., Halloysite nanotube reinforced biodegradable nanocomposites using noncrosslinked and malonic acid crosslinked polyvinyl alcohol, Polymer Composites, **3 4**, pp. 799-809, 2013. DOI: 10.1002/pc.22482

Nakamura, R. and Netravali, A. N., Morgan, A. B., Nyden, M. R., and Gilman, J. W., Effect of Halloysite Nanotubes on Mechanical Properties and Flammability of Soy Protein based Green Composites, Fire and Materials**, 9 0**, pp. 75–90, 2013. DOI: 10.1002/fam.2113

Kim, J. T. and Netravali, A. N., Performance of Protein-based Wood Adhesives and Development of Small Scale Test Method for Characterizing Adhesive Tensile Properties, J Adhes. Sci. Tech., **27,** pp 2083-2093, 2012. DOI:10.1080/01694243.2012.697658