4ak Advanced Sulfonated Polyarylenethioethersulfone Polymer and Copolymer Membranes for Fuel Cell Application

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Teaching, research and service works are essential requirements for an assistant professor. My postdoctoral experience and my graduate work provided me with a strong research background, teaching experience and the opportunity to serve others.

During my graduate career, I had the opportunity to teach an undergraduate level class, "Heat Transfer," under the supervision of faculty in the Chemical Engineering Department at Mississippi State University. I was also assigned to prepare lectures for Material Characterization course presenting theory, fundamental and experimental material characterization methods. My experience and interaction with students and faculty has inspired me to pursue a career in academia where I can share the knowledge and passion I have for the engineering sciences and research as the next generation of engineers and scientists are developed.

Following my graduate work, I received a National Research Council award as a postdoctoral fellow at the Wright Patterson Air Force Research Laboratory that provided me the chance to study the structure property relationship of sulfonated polyarylenethioethersulfone polymers (SPTES) for fuel cell membrane applications. The SPTES series of copolymers have comparable performance at room temperature and superior proton conductivity (3-4 times higher) at elevated temperatures compared to Nafion. Additionally, these polymers exhibit excellent thermal and mechanical properties and form tough, flexible films. These properties make them a more realistic membrane for medium and high temperature applications. I have examined the structure of the membranes and nanometer ionomeric aggregates with neutron scattering, x-ray scattering, TEM, SEM and AFM. Studies have shown the presence of nanoscale water domains on the order 4-5 nm [1, 2].

After setting up of the first fuel cell test kit in the AFRL/ML with capabilities of controlling anode/cathode temperature, humidity degree/ temperature of the gases and back pressure with a $5cm^2$ cell, I was able to characterize the performance of SPTES membrane assemblies. The polarization curves and the performance of the MEA were investigated by varying the temperature of anode, cathode, degree of the humidity and pressure on the membrane performance [3].

My Ph.D. dissertation was focused on polymer nanocomposites. Highly delaminated polydicyclopentadiene organically modified montmorillonite clay nanocomposites were prepared by in-situ polymerization of exfoliated clay in the dicyclopentadiene monomer [4]. The extent of clay delamination was examined by small angle neutron scattering, small angle x-ray scattering and high resolution transmission electron microscopy [5]. Exfoliated and intercalated clay/polydicyclopentadiene nanocomposites were modeled using finite element modeling to predict micromechanical behavior of nanocomposites [6]. Additionally, I investigated the synthesis and characterization of phenolic resin/carbon nanofiber nanocomposites. Functionalized carbon nanofibers showed improved dispersion and fiber/matrix adhesion when dispersed in a resole phenolic resin. Geometrical parameters such as average fiber diameter and average shell thickness as well as dispersion parameter were obtained from modeling of the scattering data [7].

Successful research necessitates interaction and involvement with broader community. To that end, I developed collaboration with the Naval Research Laboratory, Oak Ridge National Laboratory and Mississippi State University for my Ph.D. research project. I served as a session co-chair, at the 10^{th} Annual International Conference on Composites/Nano-Engineering (ICCE-10), 2003.

As An assistant professor, I would like to build a strong research group and continue working in the areas of fuel cells and nanomaterials. I am interested in teaching several classes both in the Chemical Engineering curriculum and my specialization field. I would continue on service and helping others as well as developing collaborative work with the experts in my field.

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[2] Yoonesi M Bai Z Dang T Durstock M F Vaia R A, Adv. Sulfonated Polyarylenethioethersulfone Polymer and Copolymers Polyelectrolyte Membranes For Fuel Cell Applications, manuscript in preparation.

[3] Yoonesi M Bai Z Dang T Koerner H Durstock M F Vaia R A Structural Examination of Advanced Sulfonated Polyarylenethioethersulfone Polymer and Copolymer Membranes for Fuel Cell Applications, AIChE annual meeting, 05, Cincinnati, OH.

[4] Yoonesi M Toghiani H Daulton T L Pittman C U Jr., Quantifying Delamination of Clay/PolyDicyclopentadiene Composites Using Neutron Scattering and High Resolution TEM, Macromolecules, (Article); , 2005; 38(3); 818-831.

[5] Yoonesi M Toghiani H Kingery W L Pittman C U Jr., Preparation, Characterization and Properties of Exfoliated/Delaminated Organically Modified Clay/Dicyclopentadiene Resin Nanocomposites, Macromolecules; (Article); 2004; 37(7); 2511-2518.

[6] Yoonesi M Experimental and Modeling Studies of Clay/PolyDicyclopentadiene Resin Nanocomposite, Dissertation, Mississippi State University, Aug. 04

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