Introducing CAPCE Researcher

Dr. Jim Rathman is an Associate Professor in the Department of Chemical Engineering. His research focuses on colloidal systems, interfaces, and surfaces.

One area of Dr. Rathman's research program involves the manufacture of nanostructured particles and films. These materials are formed by the polymerization of inorganic species in solutions containing surfactants. Mesoscopic structures resulting from the molecular self-assembly of surfactants are used to direct the inorganic polymerization reaction, providing a means of selectively controlling various properties of the product material, such as density, surface area, and pore size and geometry. Composite blends of silica materials and organic polymers or biomolecules are being investigated for use in diverse applications ranging from molecular sieves, sensors, protective coatings, and biomimetic surfaces. This work is currently being supported by the National Science Foundation and the ACS Petroleum Research Fund.

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Solventless Pre-Pregs for Electronic Applications

By Permadi and Liqun Xu (Castro, Lee)

The most common commercial processes for manufacturing pre-pregs for electronic applications use solvent-based epoxy systems. These solvents are environmentally-unfriendly and contribute to voids in the prepreg and laminate, which in turn cause product variability—a major source of scrap in board shops.

Our primary aim is to identify a potential epoxy-based resin system for a solventless process that is based on injection pultrusion, using chemo-rheological and kinetic measurements. Our DSC and rheological data show that without a catalyst, the candidate system does not react appreciably at temperatures below 170°C, or with a catalyst at temperatures below 110°C. The system solidifies at temperatures below 105°C. It was found that the overall viscosity of the resin system is dependent upon the temperature, degree of cure, and filler content. Expressions for kinetic rate and viscosity rise have been developed for use in process modeling and optimization. A preliminary process window for the process has been established.

Design of an Accelerated Outdoor Aging Simulator for Tire Rubber Compounds

By Bart LaCount (Castro)

Tire rubber compounds undergo aging during real service due to various environmental factors. Currently there is no standard test to simulate this aging by artificial means. Research has been completed, studying the behavior due to thermal aging, dynamic ozone aging, an outdoor aging test, and a novel multiple factor test. This cyclic aging study consisted of four single-factor subtests designed to simulate the outdoor aging by artificial means. A prototype chamber simulating real service in an accelerated fashion was proposed and then manufactured. This aging chamber incorporates the different factors and operates at a moderate temperature to avoid changing the aging mechanisms. It also utilizes small specimen size to reduce the test time to days. Several tests were run under varying conditions to allow comparison with previous work. Currently the results are being compiled and more testing is planned.

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