PURDUE CHEMICAL ENGINEERING

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Synthesis and Mechanical Properties of Magadiite/SBR Composites

This work investigates mechanical reinforcement and energy dissipation in styrene-butadiene rubber (SBR) composites containing sulfur-functional, organosilane-modified magadiite (MGD), a layered silicate. Using MGD gives us plate-like active filler particles with surface chemistry similar to precipitated silica, but with differing filler particle shape, surface area loading (filler area per mass of SBR), and silane graft density. Rationalizing the resulting composites' crosslink densities and mechanical properties in terms of these variables helps us understand reinforcement and energy dissipation mechanisms in platelet-filled elastomers. As-synthesized MGD does not react with the most widely used sulfur-functional silane (known as SI-69) or disperse well into SBR pre-polymer. Thus we first treat MGD with surfactant (CTAB) in order to expand the MGD interlayer spacing. The product, CTA-MGD, blends well with SBR and SI-69, leading to CTA-MGD/SBR composites with mechanical properties better than silica/SBR at the same filler weight loading. Next, we sought better control over MGD-SBR crosslinking by "pre-functionalizing" CTA-MGD with SI-69 or another silane (MPTES). High silane concentrations displaced all of the CTA from the MGD interlayer space, leading to interlayer contraction, no intercalation by SBR pre-polymer, and mediocre composite mechanical properties. However, low SI-69 concentrations preserved interlayer expansion enough to permit SBR intercalation and decent composite properties. Finally, we used different surfactants to prepare organo-MGD with varying initial interlayer spacing. The mechanical properties of the resulting MGD/SBR composites provide preliminary support for the "bear trap" hypothesis: greater MGD expansion leads to greater mechanical reinforcement, presumably due to more SBR intercalation and crosslinking within the MGD interlayer spaces.

Dr. Harry J. Ploehn *serves as Vice Provost at the University of South Carolina and as a Professor in the Department of Chemical Engineering. Dr. Ploehn previously served as Associate Dean for Research and Graduate Education as well as Interim Dean of the College of Engineering and Computing. Since joining South Carolina in 1995, Dr. Ploehn has taught a variety of undergraduate and graduate courses in subjects including fluid mechanics, heat and mass transfer, and advanced materials. His research, focused at the intersection of polymer materials, interfacial engineering, and nanotechnology, has been funded by industry (Michelin, MeadWestvaco, Dow Chemical, DuPont, Shell) and federal agencies (NSF, DoE, AFOSR, ONR). This body of research has been disseminated in over 90 papers in leading journals and over 140 technical presentations and invited seminars. Dr. Ploehn also holds three U.S. patents and has founded one startup company.*