Center for Glass Research (CGR)

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New Insights Glass Surfaces

Understanding the detailed physical and chemical nature of glass surfaces is key to the development of stronger and more durable glasses as well as to advancements in adhesion and performance of coatings used in many types of glass products and glass fiber based composites. Research at the Center for Glass Research has identified and energetically quantified specific chemical sites on the surfaces of various glass types that are responsible for adsorption and bonding of water and various organic molecules that are critical to these qualities. Using this information, it is now possible to develop more hydrophobic glass surfaces, better coatings and stronger interfaces. Previous improvements in glass surface properties have been accomplished largely through either through trial and error or through statistically designed experiments without specific technical knowledge of bonding or adsorption sites on the glass. Understanding glass surface site chemistry allows more technically intelligent design, e.g., of protective coatings and interfaces to maximize product performance. Glass producers and coating designers now have new and more powerful information that can enable "surface engineering", i.e., building specific properties such as strength into the surface and the interface rather than relying on the intrinsic properties of the bulk glass itself to define those surface features. Initial applications will be to the production of glass fibers with improved coatings for better protection, better dispersion in processing, and better coupling with various polymeric matrices in a variety of composite applications. Eventual applications may extend to protective and strength-enhancing treatments or coatings for containers or glass panels. For more information, contact Carlo Pantano at the Pennsylvania State University, 814.863.2071, cgp1@psu.edu.

Higher Strength Glass

Stronger, lighter weight glass products, whether they are automobile windows, architectural glazing, or beverage bottles, have the potential to benefit much of society. Continuing research, over the past ten years or more, on methods by which to strengthen glass has put the CGR at the forefront of this technical area. Knowledge gained related to chemical (ion-exchange) strengthening is enabling lighter, higher strength glass products to be manufactured. CGR researchers received a Department of Energy Office of Industrial Technologies grant (DE-SC02-97CH10875) to continue these studies and to demonstrate practical applicability of their ideas to producing stronger, yet lighter weight, glass windows. While there are economic (cost) barriers for some applications, for others these should be surmountable. Pilot production of such strengthened glasses is imminent. For more information, contact Dr. Tom Seward, 607.871.2432, seward@alfred.edu.

Redox (Oxidation State) Studies

Major insights have been gained into the understanding of the oxidation state of glass melts. Research conducted by Dr. Henry D. Schreiber under CGR and NSF funding at the Virginia Military Institute has greatly extended our ability to ascertain the degree and mechanisms of mutual interaction of important redox (reduction-oxidation) couples (for example, Fe/Cr, Fe/Ce, and Fe/Mn) in soda-lime-silica glasses and glass melts; to develop in situ electrochemical procedures for soda-lime-silica and borosilicate glass melts and understand and control the melt's redox state; and to correlate in situ electrochemistry to the redox state of glass-forming melts. These research findings are important to processes involved in the melting and fining of glass and for controlling color in commercial glass. One CGR member company, Visteon Corporation, the automotive glass producing subsidiary of Ford Motor Company, claims that nine (9) U.S. patents in the areas of manufacturing processes, glass color (tint) and glass quality were stimulated by this CGR-sponsored research. For more information, contact Dr. Tom Seward, 607.871.2432, seward@alfred.edu.

Glass for Toxic Waste Encapsulation

Specialized glasses and glass melting processes are at the heart of toxic waste vitrification, particularly of low-level and high-level radioactive waste, for long-term storage. Research sponsored by the CGR at Alfred University and the Virginia Military Institute has led to major insights into understanding the oxidation state of such glass melts, including the degree and mechanism of mutual interactions (oxidation-reduction reactions) among the many multivalent elements present. This is at the heart of understanding and predicting chemical durability of the glass, which is important for assuring long-term stability during underground storage. This information has been found extremely valuable by at least one of our member companies, the Westinghouse Savannah River Company, and several national laboratories involved with nuclear waste vitrification. For more information, contact Dr. Tom Seward, 607.871.2432, seward@alfred.edu.

Energy Efficiency, Modeling and Glass Melt Properties

Glass manufacturing involves some of the country's most energy-intensive industrial processes. Mathematical modeling is a useful approach toward improved, less energy-consuming processes. However, predictions of models are no better than the quality of data on which they are based. Between 1996 and 2003, with additional funding from the DOE Office of Industrial Technologies (Grant #DE FG07-96EE41262), CGR researchers studied and measured high temperature glass melt properties of six commercially important families of glass: window and architectural glass ("float glass"), container glass, textile and insulation fiberglass, low-expansion automobile headlamp and laboratory glass, and color television picture tube glass. This was done to the high degree of reliability needed by the modelers. Some properties, such as the photonic contribution to high temperature heat conductivity, had never before been measured for these types of glass. At least 8 member companies have testified to the value of this database and 4 (U.S. Borax, Visteon Corporation, Guardian Industries and Techneglas) are actively using the information it contains. For more information, contact Dr. Tom Seward, 607.871.2432, seward@alfred.edu.