Introduction to Advanced Transportation

Fundamental research can play a role in reducing greenhouse gas emissions associated with growing global transportation energy use by enabling technologies that either significantly reduce the energy requirement of transportation or reduce greenhouse gas emissions associated with the fuel chain. Reducing the energy requirement for transportation may be accomplished by reducing vehicle mass, smoothing the operational speed profile, and reducing viscous and contact friction. Specific technical challenges in these areas include the low-cost production of high-strength, low-weight materials and the technical foundation to enable automated vehicles.

Fuel chains with low net greenhouse gas emissions include portable storage of low-carbon electricity and carbon-based fuels synthesized from low-carbon energy. Significant technical challenges in this area include developing batteries with high energy density and stability, and developing classes of low-cost catalysts capable of efficiently converting low-carbon energy into and out of forms amenable for portable storage. There is currently one active program in this area that addresses the problem of electrical storage in light-duty electric vehicles.

A project that began in 2015 led by Professor Dauskardt was aimed at examining vehicle light-weighting with polymeric glazing and moldings. There is a strong desire in the transportation community for a molding process, which would allow a wider range of shapes and aerodynamic designs in addition to providing weight reduction. This project was aimed at improving the durability, performance and lifetime of novel polymeric glazings and moldings. The researchers demonstrated a deposition method that fabricates coatings in a one-step process, significantly overcoming challenges in what is typically a three-step process. They focused on creating a mechanically robust polymeric glazing that offers UV-protection to the underlying polymer substrate and demonstrated a novel dual-source deposition method. This new method is capable of incorporating several different functional nanoparticles into the coating matrix with good nanoparticle dispersal, uniformity and strong matrix-nanoparticle interfacial interactions, which are crucial for achieving the best coating properties. As a result, coatings with exceptional stiffness and UV-protection were successfully deposited. In addition they developed an ultra-high adhesive spray coated hybrid layer on PMMA, compatible with plasma deposited top dense layers. They achieved adhesion energy of 65 J/m^2, which is 8 times higher than the commercial sol-gel polysaloxane coatings, by optimizing the sol-gel chemistry. The final bilayer structure exhibited an extremely good combination of adhesion and stiffness as compared to the commercial sol-gel polysiloxane coatings. This work has produced two publications.