

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 decouple vehicle energy use and emissions. 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.

Professors Philippe Poizot, Jean-Marie Tarascon, Michel Armand, Christine Frayret, Franck Dolhem of the University of Picardie, Jules Verne, France, are developing advanced Li-ion batteries using renewable organic electrodes. Current Li-ion battery components are not produced through renewable resources and require large amounts of energy for material extraction, processing, and end-of-life recycling. Organic materials have the potential to be used for high-performance battery electrodes with the benefit of avoiding many of the energy costs associated with processing and recovering inorganic cathode materials. Research progress has centered on the redox activity of quinone-type structures, with the aim to grasp the relevant parameters that affect the redox potential of an organic electroactive material, its reactivity, and its stability upon cycling.