

Introduction to Advanced Materials and Catalysts

The development and advancement of materials is an overarching need in systems that extract, distribute, store or use energy. The performance of these systems depends on the materials. Plastics, coatings, alloys and catalysts are some of the broad classes of materials used in current energy products. Advancements in these materials optimize energy conversion processes, improve system efficiency, extend lifetime, and reduce CO₂ emissions. Although initially developed for a specific application, material properties may crosscut to other energy technologies or industries.

The molecular structure of a material determines its mechanical strength, surface area, permeability to fluids and chemical reactivity. Furthermore, the stability of that structure impacts the durability in the harsh environments of highly cyclic mechanical, thermal and chemical loading present in energy and resource processing devices. The structure and stability of a material affect its functionality, while the resources required to manufacture the material determine its economic feasibility. Materials structured at the nanometer scale have become a common area of research due to their unique and unexpected macroscopic characteristics.

GCEP has several projects whose main focus is on materials development. Most of these are officially listed under their application area. Some projects have a materials component to their research. In the Hydrogen area the projects are Nanomaterials for Hydrogen Storage, NMR Studies of Fuel Cell Electrolytes, Micro and Nanoscale Electrochemistry of Fuel Cells. A study in the CO₂ Separation and Capture area is Advanced Membrane Reactors and Development of Innovative Gas Separation Membranes. The Solar area is replete with materials research for nanostructured photovoltaic cells. The studies listed above are all materials intensive investigations whose details can be found under their specific application areas in this report. The remainder of this section is dedicated to an investigation of Electrocatalysts for Hydrocarbon Fuel Cells (Chidsey, Stack, Waymouth).