Energy Materials Center at Cornell (emc [2])
EFRC Director: Héctor D. Abruña
Lead Institution: Cornell University

Mission Statement: *To advance the science of energy conversion and storage by understanding and exploiting fundamental properties of active materials and their interfaces.*

Few aspects are as pervasive and important in energy generation, conversion and storage as the nature and structure of interfaces. Reactions at electrodes in fuel cells, charging and discharging reactions in lithium ion batteries and supercapacitors, and numerous catalytic systems all depend critically on the nature and structure of interfaces between materials and/or different states of matter. Despite their fundamental importance and evident technological relevance, our understanding of these processes is, at best, rudimentary. This is due, at least in part, to the lack of well-defined systems, both experimental and computational, as well as techniques that can provide structural and compositional information *in-situ* and under realistic operating conditions. This is especially true for systems that normally operate far from equilibrium.

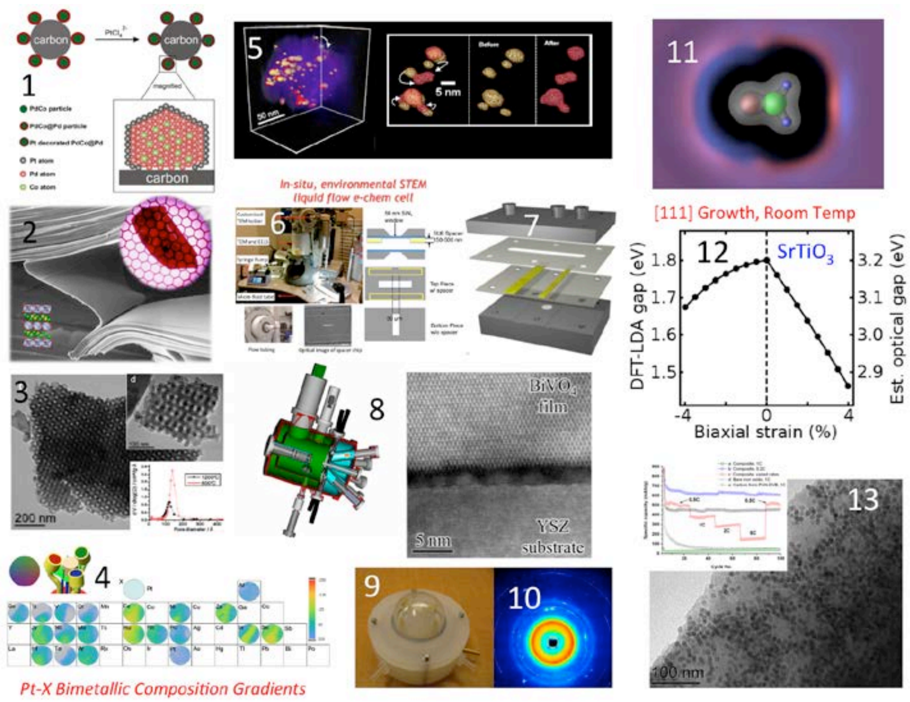

Figure 1

The aim of the Energy Materials Center at Cornell is to achieve a fundamental understanding of the effects of the nature, structure, and dynamics of these interfaces on energy generation, conversion and storage with emphasis on fuel cells and batteries.

The center integrates the synthesis of materials and nanostructures as catalysts and catalyst supports for fuel cell applications (Fig. 1: 1,2,3,4), their ageing dynamics with atomic resolution (Fig. 1: 5), synthesis and characterization of battery materials (Fig. 1: 13), the synthesis and characterization (with atomic precision and resolution) of core/shell catalysts (Fig. 1: 1) and complex oxides (Fig.1: 8), in-situ characterization via x-rays (Fig. 1: 9,10), development of novel experimental techniques (Fig.1: 5,6,7,9) along with combinatorial high throughput methods (Fig. 1: 4) and screening as well as computational studies (Fig. 1: 11,12).

The knowledge-base emerging from these efforts will guide the synthesis of improved materials and the development of novel tools and testing capabilities that will provide *in-situ* spatiotemporal characterization over the range of conditions in which the appropriate technologies are intended to operate.

The proposed studies are aimed at greatly accelerating the development of energy conversion technologies by providing the fundamental knowledge-base for the rational development and synthesis of new materials, as well as experimental and computational tools necessary for and critical to optimization of properties and, thus, performance.

The fundamental challenges that we will address include:

- Achieve a microscopic understanding of the effects of the nature and structure of nano-structured interfaces between dissimilar materials including metal/conducting polymer, and at "atomically engineered" complex oxides, on energy generation, conversion and storage
- Develop and apply novel experimental tools for probing the dynamics and kinetics of structure and chemistry at interfaces, in films and in model devices
- Develop and employ computational and modeling platforms to understand the fundamentals underlying the above phenomena

Potential Impact:
These investigations will dramatically accelerate the development of energy generation, conversion and storage technologies with emphasis on fuel cells and batteries and thus, the evolution of the entire energy landscape.

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