Controlling Optical Properties of Functional Mesoscale Systems Via Multi-Scale Interfacial Interactions

Opportunity

- Controlled and enhanced materials functionality via mesoscale interfacial interactions.
- Nanomaterial (e.g. carbon nanotubes) surface sensitivities introduce significant opportunity to control optical response via interfacial environment.
- Tailoring surface structures can define matrix interactions as a route to functional photonic composites.
- Defining multi-scale and multi-component materials interactions can unlock novel emergent optical behaviors.

Approach

- Control interfacial and surface chemistry to define interactions with matrix materials.
- Adjust mesoporous (hydrogels, aerogels, etc.) matrix properties to define materials interactions.
- Define compositions of active components.
- Exploit materials interactions to access emergent phenomena.
- Develop imaging and spectroscopic tools to probe the nature, fate, and dynamics of optical excitations in complex, low-dimensional environments.

Meso Challenge

- How control and model dynamic and disordered interfacial structures (e.g. surfactant structure surrounding carbon nanotube surface)?
- How connect low-dimensional structures into larger scale composites?
- How control access to active site surfaces?
- How do we understand and control the low-dimensional surface mobility and interplay of dopants, excitons, and dynamic structures?

Impact

- Understanding low-dimensional surface chemistry and models for interfacial structures.
- Reveal true intrinsic and emergent optical responses masked by environmental interactions.
- Address the general challenge of harnessing nanoscale behaviors to translate them into functional optical materials.
- Applications potential in photovoltaics, photonics, quantum optics, sensing.

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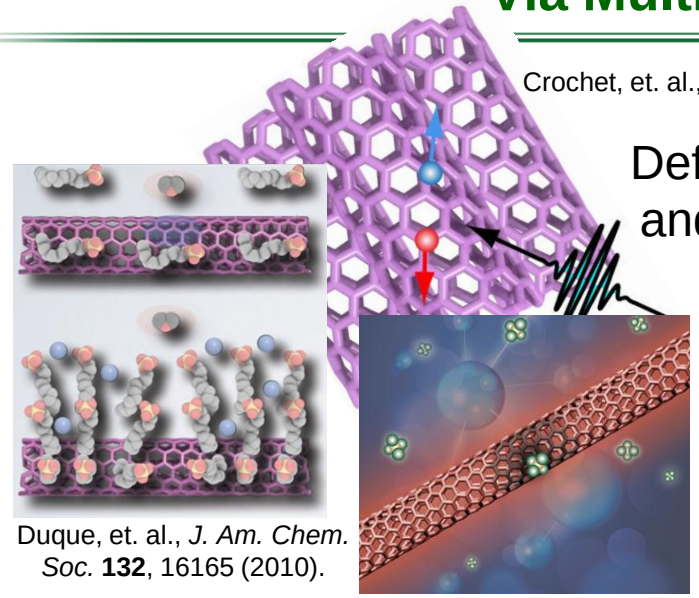
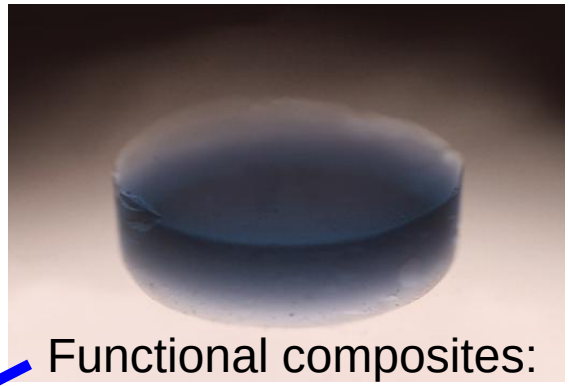


Duque, et. al., *J. Am. Chem. Soc.* **132**, 16165 (2010).

Crochet et. al., *Nature Nanotech*, **7**, 126 (2012).

Crochet, et. al., *Phys. Rev. Lett.*, **107**, 257402 (2011).

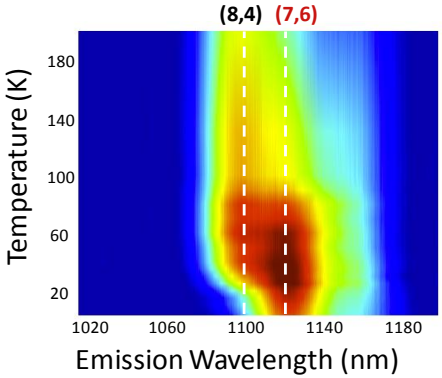
Defining surface, interfacial and materials interactions.



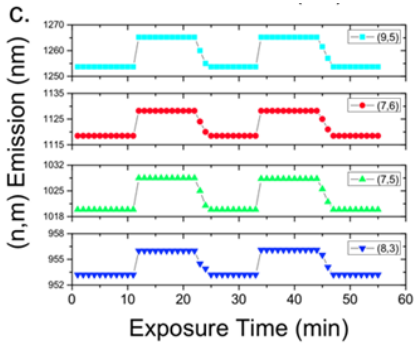
Functional composites: retaining and enhancing optical properties.

Duque, et. al., *ACS Nano*, **5**, 6686 (2011).

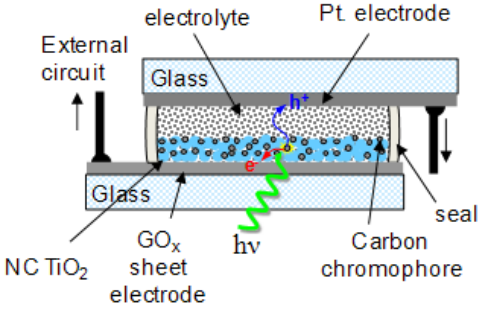
Enabling new behaviors and applications.



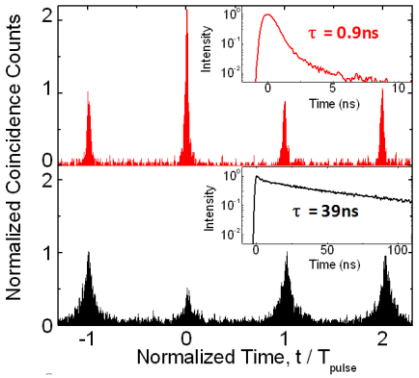
Emergent Physics



Sensing



Photovoltaics



Quantum Optics

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