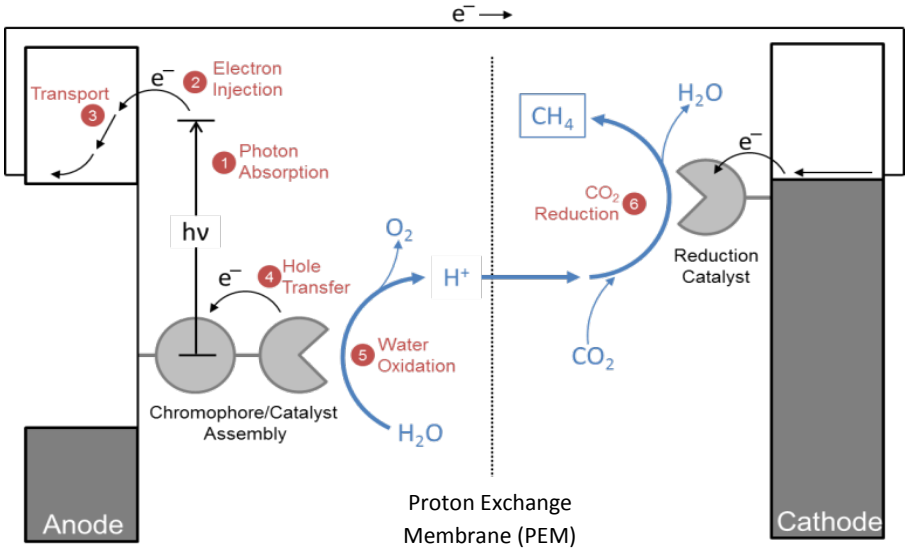
Center for Solar Fuels (UNC)
EFRC Director: Thomas J. Meyer
Lead Institution: University of North Carolina at Chapel Hill

Mission Statement*: To integrate academic and translational research to study light/matter interactions and chemical processes for the efficient production of solar fuels.*

The UNC EFRC is conducting research on capturing sunlight to drive solar fuel reactions. The Center's efforts range from basic research on fundamental processes to integrating components into sub-systems and sub-systems into prototypical devices. The research utilizes a broad, multidisciplinary approach in a highly collaborative setting drawing on expertise across a broad range of disciplines in chemistry, physics, and materials sciences. The primary target is a Dye Sensitized Photoelectrosynthesis Cells (DSPEC) for solar fuels production as illustrated below.



Dye-Sensitized Photoelectrosynthesis Cell (DSPEC)

SOLAR FUELS

Multiple platforms are under investigation but the primary focus is on Dye Sensitized Photoelectrosynthesis Cells (DSPEC). This approach utilizes molecules and molecular assemblies for catalysis in photoelectrochemical configurations closely related to those used in Dye Sensitized Solar Cells (DSSC). The Figure shows a schematic diagram for a DSPEC for light driven water reduction of CO_2 to methane. In contrast to a DSSC, where the target is creating a photopotential and photocurrent, the target of a DSPEC is production of a high energy fuel with oxygen as the co-product in the physically separated compartments of a photoelectrochemical cell. **The UNC EFRC approach is distinctive based on the design and utilization of separate functional modules, maximizing their performance, and integrating them into device prototypes featuring both single and tandem photoelectrode configurations.**

Multiple themes have been developed in parallel – light absorption, excited state electron and energy transfer, electron and proton transfer driven by free energy gradients, and catalysis of water oxidation and water/CO_2 reduction – with integration in photoelectrochemical cell configurations. In the modular approach the separate components are designed and tested for maximum performance and then integrated into the final DSPEC architecture. DSPEC research benefits from, and is enriched by, parallel research in electrocatalysis and Dye Sensitized Solar Cells.

Hallmarks of Center research are: (1) fundamental studies on reaction mechanisms, (2) synthesis of novel materials combining light absorption and catalysis, (3) preparation and characterization of designed photocatalytic interfaces, (4) application of theory and experiment to provide guiding principles for component design, integrated systems, and devices, and (5) augmentation of research findings and multidisciplinary strengths in research collaborations with national laboratories, other EFRCs, and the Research Triangle Solar Fuels Institute (www.solarfuels.org). The latter has been a key partner, extending the research findings of the EFRC through the translation stage to device prototypes.

TEAM STRUCTURE and RESEARCH FOCUS

The Center employs an integrated, interdisciplinary team-based approach to research in Solar Fuels based on four research areas, **Catalysis**, **Assemblies, Interfacial Synthesis and Characterization**, **Device Prototypes.** Eight research teams, led by faculty members at UNC and partner institutions, pursue research in these areas with the Theory team fully integrated into the experimental teams.

RESEARCH THRUST	TEAM	TEAM RESEARCH FOCUS
Catalysis	Water Oxidation	Development of new solution and interfacial catalysts for water oxidation.
	CO_2 Reduction	Development of new solution and interfacial catalysts for CO_2 reduction.
Assemblies	Polymers	Synthesis and characterization of molecular assemblies based on polymer scaffolds for multi-chromophore applications and chromophore-catalyst applications.
	Peptides	Molecular assemblies based on peptide scaffolds for exploitation of antenna effects and chromophore-quencher applications.
	Framework Materials	Organic-inorganic hybrid materials for integrated light-harvesting and catalysis.
Interfacial Synthesis and Characterization	Interface Synthesis	Synthesis and attachment of chromophore-catalyst assemblies at metal oxide interfaces.
	Interface Characterization	Characterization of interfacial structure and dynamics by transient and surface spectroscopies.
Device Prototypes	DSSC/DSPEC Devices	Evaluation and performance of integrated catalysts, assemblies and new transparent metal oxide semiconductors in device prototype configurations.
Theory	Theory	Research integrated across the Center on reaction pathways, electron and energy transport, molecular design, systems analysis.

Center for Solar Fuels	
University of North Carolina at Chapel Hill	T.J. Meyer (Director), K. Brennaman, M. Brookhart, J. Cahoon, J. Concepcion, J. Dempsey, M. Forbes, Y. Kanai, S. Keinan, W. Lin, S. Liu, R. Lopez, A. Miller, A. Moran, R. Murray, J. Papanikolas, E. Samulski, C. Schauer, J. Templeton, M. Waters, Y. Wu, W. You
Duke University	D. Beratan, M. Therien, W. Yang
Georgia Institute of Technology	J. Reynolds
North Carolina Central University	D. Taylor
University of Florida	K. Schanze
Research Triangle Institute	P. Hoertz
University of Colorado/ NREL	A. Nozik

Contact: Thomas J. Meyer, Director UNC Energy Frontier Research Center
Arey Distinguished Professor of Chemistry, tjmeyer@unc.edu, www.efrc.unc.edu