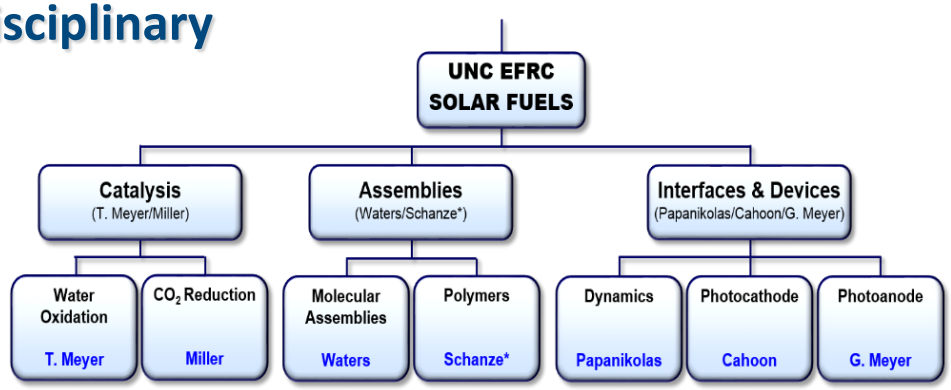
UNC Energy Frontier Research Center
CENTER for SOLAR FUELS

SOLAR FUELS

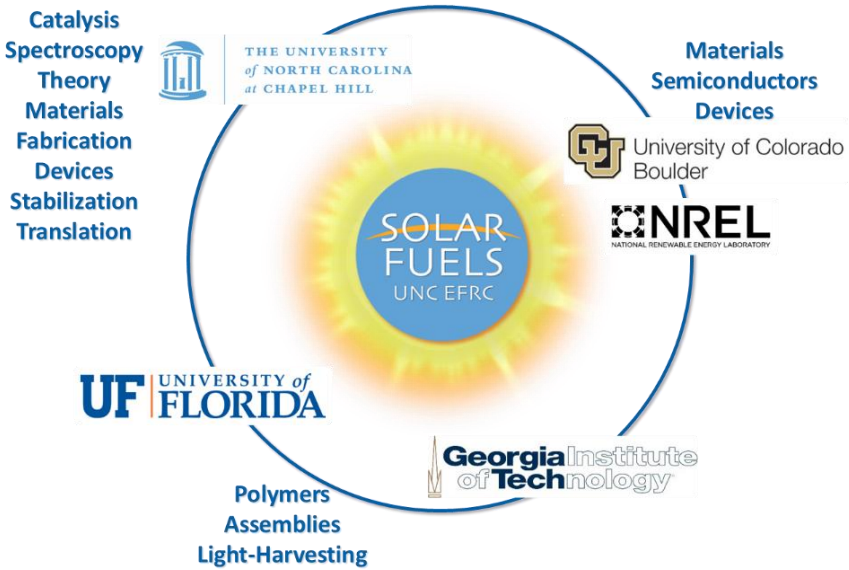
RESEARCH: Modular, Team-Based, Multidisciplinary

- Inter-institutional collaboration and integration
- Professional research staff – continuity, training, expertise, leadership
- World-class research facilities in spectroscopy, synthesis, analysis, materials, device fabrication, translation, scale up



ACCOMPLISHMENTS

- 188 publications, +10 under review
- 1 patent, 18 patent applications, 22 reports of invention
- 65 postdoctoral fellows, 85 graduate students, 30 undergraduates trained or in training; 46 graduate degrees awarded; >100 alumni careers in industry, academia, government, policy, public sector
- Active partnerships and collaborations with other EFRCs, academia, national labs and industry
- 190 invited EFRC leadership presentations to US government and NC state representatives and agencies, DOE, universities, industry, venture capitalists, public lectures, workshops, etc.



UNC ENERGY FRONTIER RESEARCH CENTER

U.S. DEPARTMENT OF ENERGY | Office of Science

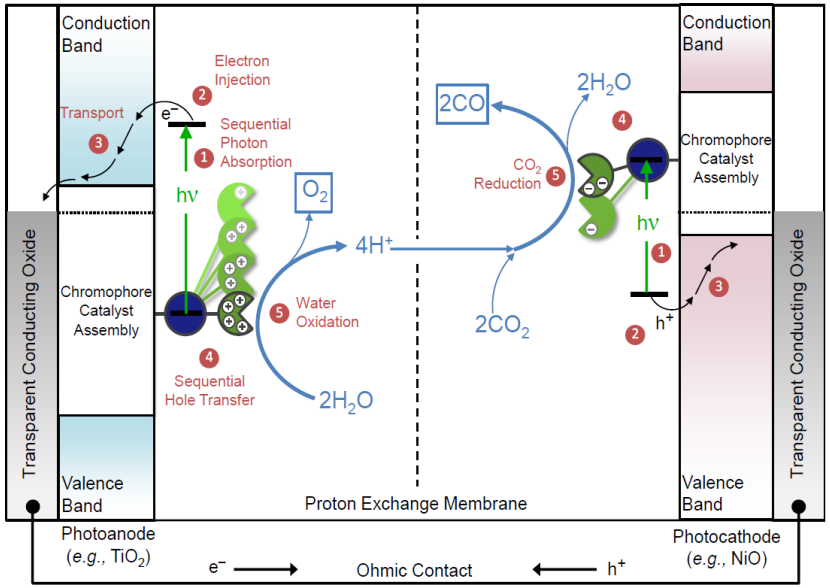
SOLAR FUELS
Dye Sensitized Photoelectrosynthesis Cells

Solar Water Splitting, Tandem Cell Reduction of CO_2 to Reduced Carbon - Formate, Syngas

- Light absorption; water oxidation and CO_2 reduction catalysis; chromophore-catalyst assemblies
- Oxide surface binding and stabilization; oxide semiconductors; interfacial electron transfer dynamics
- Photoanode, photocathode, DSPEC tandem cell applications

Accomplishments, Future Research

- Successful design/implementation of working DSPECs for water splitting: extend light absorption, stabilize surface binding, maximize efficiency
- Selective, high efficiency electrocatalytic CO_2 reduction of CO_2 to formate or syngas (H_2:CO) mixtures; water oxidation to O_2 including 1st row metals: incorporation into photocathode applications; use first row catalysts
- Chromophore-catalyst assemblies, layer-by-layer, electro-assembly, co-loading: simplify and stabilize, use organic chromophores
- Stabilization of assembly surface binding and preparation of core/shell structures by atomic layer deposition (ALD) and electropolymerization: exploit the core/shell concept, use ALD and polymer overlayer surface stabilization
- Stability and scale up of working DSPEC devices



Target Metrics

- >90% efficient conversion of solar photons into redox equivalents (steps **1** and **2**).
- >95% efficient build up of multiple redox equivalents at catalyst sites for water oxidation or CO_2 reduction on the timescale of the light source, seconds for ambient sunlight (steps **3** and **4**).
- Catalytic rates of $>10^2$ s^{-1} (step **5**).
- Device efficiencies of 15% with 10^7 cycles/yr and a 95% retention in photoreactivity.