Probing mechanisms and theory from molecular interactions to process design, Jackson group efforts range from fundamental...:

- Nature, scope, and applications of hydridic-to-protonic hydrogen bonding\textsuperscript{2,3}
- Computational modeling to design and interpret reaction mechanisms and structures\textsuperscript{3-7}

...to eminently practical chemistry:

- “Green” catalytic pathways from renewables to useful “petro-“ chemicals\textsuperscript{8-10}
- Alkali metal reductants “tamed” by dispersion in silica or alumina.\textsuperscript{11}

More information can be found at \url{http://www.cem.msu.edu/~jackson}; two active areas are outlined below, where the common thread is mechanistic. By understanding molecular interactions and reactions we seek rules to design materials and processes with targeted characteristics. From the post-doc to the high-school level, scientists trained in the group have gone on to excellent positions in academia, industry, or governmental research.

**Hydridic-to-protonic hydrogen bonding:**

Our discovery and studies of this interaction, AKA dihydrogen bonding, began with a high school student studying NaBH\textsubscript{4}·2H\textsubscript{2}O (Fig. 1). Besides the novelty of hydrogen’s serving as the nucleophile in a hydrogen bond, this work has uncovered reactions governed by the material’s phase and local stoichiometry as well as a bona fide crystal-to-crystal solid state transformation. Dihydrogen bonding projects have focused on crystal engineering, design of bond-selective infrared activated reactions; and searches for possible biological and synthesis assignificance.\textsuperscript{5}

**Green Chemistry:** We seek to replace fossil petroleum with renewables as the basis for chemicals and fuels via catalytic paths starting from biomass-derived feedstocks, most recently the liquids from fast pyrolysis of plant matter.\textsuperscript{9-9} Target products are commodity and specialty chemicals and fuels. Reaction optimization is guided by mechanistic explorations of rates, substituent effects, isotopic labeling, and variations in media and conditions.\textsuperscript{9} Meanwhile, novel nanocatalyst syntheses are also under development.\textsuperscript{10}

![Fig. 2. Electrocatalytic hydrogenation (ECH) of methoxophenols over a skeletal nickel cathode cleaves the aryl ether bonds and hydrogenates the product phenol.](image)

are now intersecting the dihydrogen bond (fundamental) work; interfacial dihydrogen bonding of metal-bound hydride sites under water seems to strongly affect their reactivity. In turn, the quest for “biomass refinery operations” via electrocatalytic reduction of bio-based feedstocks unexpectedly found aryl ether cleavage over a simple Nickel electrode (Figure 2).\textsuperscript{9} Such serendipities and synergies at the borders of practical and fundamental; synthesis, structure and mechanism; and experiment and theory pull us back inexorably to the lab each day. Come join us; there’s always room for another partner in the search!