



Left to right: Stephen McNeil, Kevin Smith and Alaa Abd-El-Aziz

Materials for the Future

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In each investigation, we dream, we design, and we make it happen. When an investigation doesn't work it challenges us to become more creative.

From fade-resistant paints and coatings, to novel methods of plastic manufacturing, to new potential drugs, the Laboratory for Organometallic Chemistry of First-Row Transition Metals (the 1st OTM Lab) is, without question, a place of production and synthesis. The 1st OTM Lab houses the innovative research of organometallic and polymer chemists Professor Alaa S. Abd-El-Aziz, Associate Professor Kevin M. Smith, and Assistant Professor W. Stephen McNeil.

Organometallic chemists synthesize molecules that contain both metals and carbon atoms—a fusion reflected in the many applications pursued in the 1st OTM Lab, which also blend the organic with the metallic. Current research projects involve the incorporation of metal atoms into organic materials, the use of organometallic catalysts to direct the formation of new carbon-carbon bonds in polymerization and synthetic reactions, and the exploration of metal compounds as new pharmaceuticals.

The synthesis of 1st OTM molecules—unnatural molecules characterized by extreme air sensitivity—often requires complete exclusion of air and water, and that calls for custom-designed equipment such as an inert-atmosphere glove box, just one of the many technologies in the 1st OTM Lab.

“The molecules and materials designed and created in our lab have never existed anywhere before, which is one of the most exciting and satisfying components of our research,” says Smith. For organometallic chemists, the formulation of new molecules is just the first step.

“Once we’ve made the molecules, we need to understand the relationship between their structure and their reactivity,” adds Smith, listing the series of cause-and-effect relationships that arise.

“For materials, modifying the synthetic route enables you to control the structure. This change in the molecular structure leads to different physical properties of the materials, in turn allowing them to be employed for a range of applications. For catalysts, minor changes in the properties of the organic molecules bound to the metal can lead to dramatic differences in their reactivity and overall performance.”

In Abd-El-Aziz’s research, these variations affect the magnetism, colour, or conducting properties of new macromolecules, polymers and dyes, research that Abd-El-Aziz describes as “incredibly rewarding.”

In Smith and McNeil’s research, the changes determine the ability of a molecule to absorb or release organic radicals in a controlled fashion; challenging chemistry with applications in polymerization, catalytic synthesis, and perhaps even the control of harmful reactive oxygen species in the body.

“The ability to design and create entirely new compounds gives us enormous flexibility,” says McNeil. “We learn a lot from compounds we can find in Nature, but we needn’t be limited to the properties they make available. Instead, we can develop and control entirely distinct behaviour at the molecular level, which eventually results in improvement to practical applications in materials, in chemical synthesis, or in medicine.”