

Inorganic-Organometallic, Analytical, and Materials Chemistry

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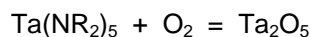
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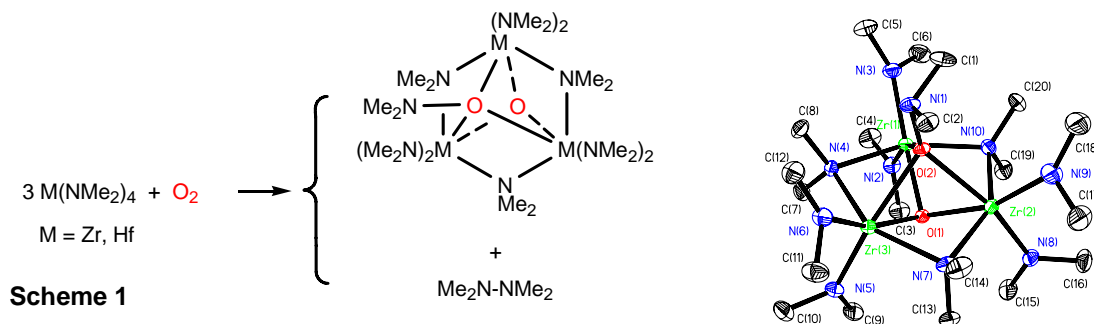
Our research program is centered on two areas: (1) organometallic-inorganic chemistry related to the formation of microelectronic materials, and (2) new analytical methods. These areas involve research in both fundamental chemistry and applications in high-tech materials. The research gives us opportunities to practice the science of molecular and solid-state synthesis and to understand the fundamental mechanistic pathways in the reactions. These research projects have been funded by the National Science Foundation (including Young Investigator Award, and Special Creativity Extension Awards), National Institutes of Health, Department of Energy, NASA, Camille Dreyfus Teacher-Scholar Award, and DuPont Young Professor Award.

1. Inorganic-Organometallic Chemistry and Molecular Routes to Advanced Materials

Advanced materials are at the heart of the current very-large-scale-integration (VLSI) devices.¹ Recent developments to make metal oxide gate materials have been called “The most significant change...since Intel pioneered the modern...transistor in 1960s.”^{1b} These metal oxide gate materials are prepared by, e.g., the reactions of amide complexes with O₂:



We have investigated the mechanistic pathways in the formation of the metal oxide thin films and other microelectronic materials.² Novel model compounds such as those in Scheme 1 have been isolated and characterized. The reactions of d⁰ metal complexes with O₂ are a new area in inorganic chemistry.



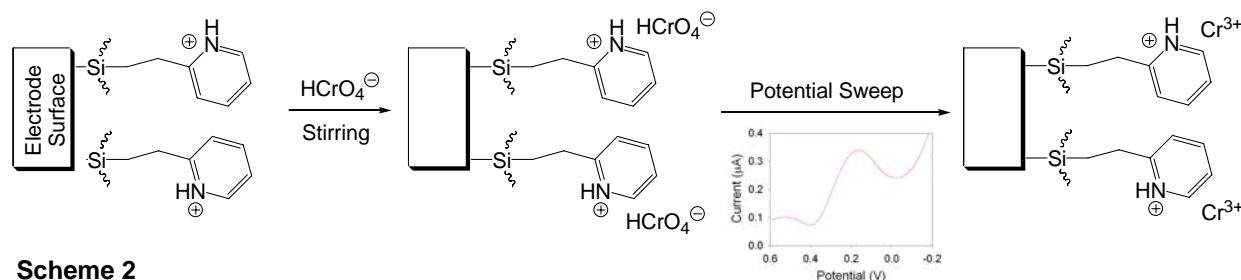
In collaboration with scientists at ORNL, we have been developing new routes for the preparation of rare-earth aluminates as buffer layers for high-temperature superconductors and layered ferroelectrics of the general formula (Sr,Ba)Bi₂(Nb,Ta)₂O₉.³ These sol-gel routes have produced epitaxial aluminates on SrTiO₃ (100) single crystals and highly oriented thin-films over silver and single-crystal SrTiO₃ substrates.

2. New Analytical Methods

Development of new analytical methods is often an interdisciplinary approach. Advanced materials play an important role here. We have worked on new methods for analysis of inorganic and organic compounds and biological species.

We developed earlier durable acid and base sensors by sol-gel methods for in-situ high acidity ($[H^+] = 1-9\text{ M}$) and basicity measurements. These sensors are based on the spectroscopic changes of organic indicators in sol-gel thin films.⁴

Our recent work has focused on new analytical methods for metal ions including chromium in biological fluids. There is a need to develop new reliable methods for the analysis of chromium in biological fluids to assess chromium deficiency and the effect of chromium as adjuvant therapy for Type 2 diabetes.⁵ The approach we are developing involves the pretreatment of blood samples to remove organic species and convert chromium to chromate. Subsequent analysis of chromium requires sensitivity at the low ppb or ppt level.^{5a}



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