Directed Self-Assembly Exploiting Combustion Synthesis for Next-Generation Nanomanufacturing

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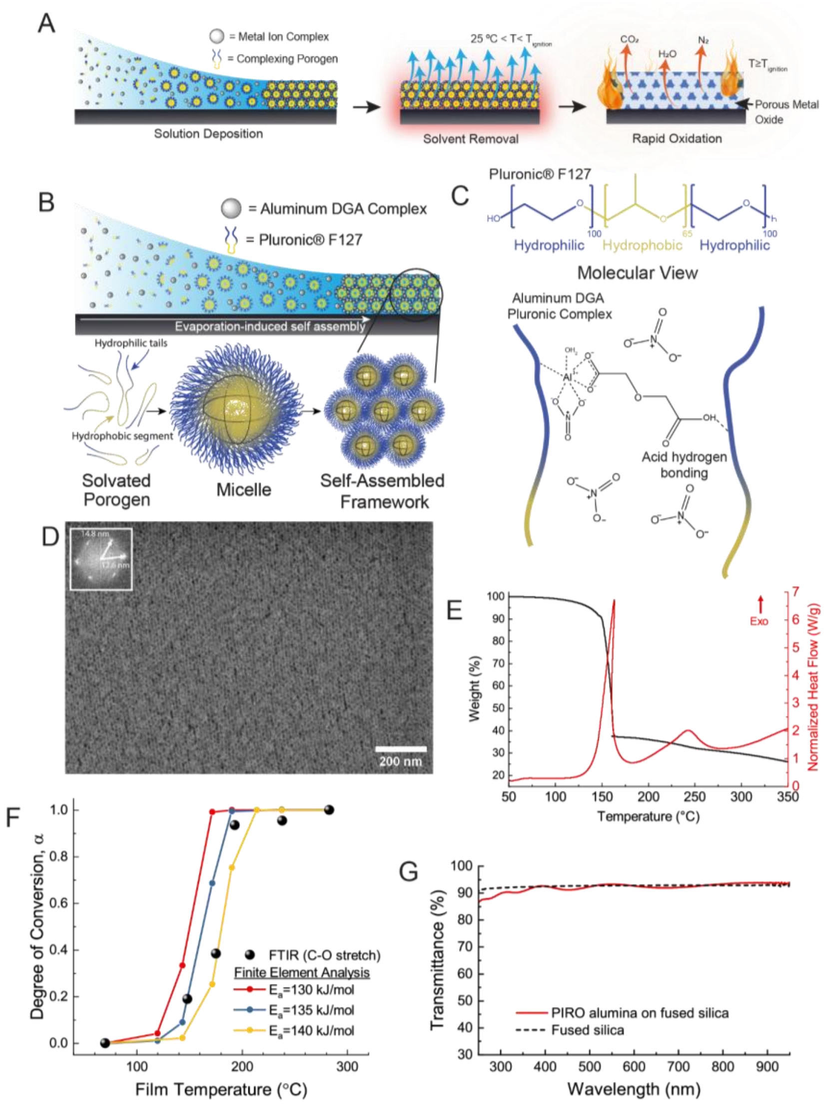
Structured metal oxide films have promise in optoelectronics, sensing, energy storage, and catalysis, however, current manufacturing techniques to form the mesoporous oxides involve expensive and low-throughput fabrication techniques. Porous metal oxides generated via traditional sol-gel approaches often require aging and sintering processes over many hours or days to yield controlled, meso-scale porosity at the cost of manufacturability.

I will describe research showing how we use a self-assembling polymer to act as the fuel source in a combustion reaction to generate highly structured nanoporous aluminum and other transition metal oxide films at <250°C in a matter of minutes through a process we term porogen-integrated rapid oxidation (PiRO). The resulting films show an open-cell, face-centered cubic structure of spheroidal pores. Further, an additional ligand can be coordinated to the metal cation to control the self-assembly step.

Finally, we demonstrate roll-to-roll manufacturing with PiRO on flexible polymeric substrates. The nanoporous metal oxide films can be filled with a second phase polymer phase to produce nanocomposite films with desirable mechanical, thermal and dielectric properties. Our method therefore offers a tunable, scalable, low temperature, and hence lower-cost method to generate large area structured nanoporous and nanocomposite metal oxide films.



Porogen integrated rapid oxidation (PiRO) greatly enhances manufacturability of thin film transition metal oxides with ordered nanoporosity.

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