# Materials Development

Materials development is an integral part of our technology development activities for the chemical, refining, transportation, and power industries. We maintain a world-class catalyst, sorbent, and membrane synthesis program focused on coupling suitable materials with specific process designs. We work together with industrial and government partners on substantial materials development programs. We also offer comprehensive development, synthesis, characterization, and testing services to industrial clients.

## Catalyst and Sorbent Synthesis

Catalysts and sorbents are integral to RTI's process development activities. For more than two decades, RTI has developed novel supported-metal catalysts, mixed-metal oxide catalysts, zeolites, and metal-organic frame-works (MOFs) to solve challenging, energy-related problems. RTI has assembled the researchers and facilities necessary to maintain a world-class catalyst synthesis program. The flexibility of our resources allows for the synthesis of different types of catalysts and sorbents by various techniques—co-precipitation, impregnation, spray drying, extrusion, and pelletization. RTI has particular expertise in developing highly active and physically strong catalysts—properties that tend to be mutually exclusive during development for fast-fluidized or circulating reactor systems. RTI is also one of the few places worldwide capable of producing MOFs at kilogram scale.

The backbone of RTI's catalyst synthesis program is a large wet-chemistry laboratory that is fully equipped with laboratory- to pilot-scale equipment for the production and optimization of catalyst formulations. Specialized equipment includes a Niro Mobile Minor spray dryer used for spray drying kilogram batches of catalyst or sorbent materials and a Bonnot extruder for preparing catalyst pellets of many shapes and sizes.

RTI has developed and scaled up a number of catalysts and sorbents for a variety of applications, including:

- Desulfurization sorbents for warm-temperature syngas
- Regenerable $CO_2$ capture sorbents for flue gas and syngas
- Iron-based Fischer-Tropsch catalysts
- Naphtha and diesel desulfurization catalysts
- Syngas sorbents for multicontaminant removal
- Fluid-bed methanation catalysts
- $CO_2$ utilization catalysts
- Chemical looping materials
- Biomass pyrolysis de-oxygenation catalysts
- Sorbents for hydrogen chloride removal
- Catalysts for ammonia adsorption/decomposition

### Catalyst and Sorbent Characterization

Catalyst characterization facilitates the rapid optimization of catalyst composition and production process to maximize activity and provide superior physical properties. RTI's capabilities in catalyst characterization complement our catalyst synthesis program. A wide range of analytical equipment is available, allowing us to effectively evaluate and screen novel catalyst preparations.

## Catalyst and Sorbent Testing

RTI has a variety of reactors, including fixed-bed, fluidized-bed, and continuous stirred-tank reactors, ranging in size from micro-reactor to 5-inch diameter, to test catalysts for their selectivity, activity, and durability. RTI maintains a sophisticated laboratory that allows us to test catalysts over a wide range of temperatures and pressures and gives us the ability to blend various reactive, corrosive, and toxic feed compositions. We can also analyze effluent compositions using different gas chromatographs and continuous analyzers.

RTI has world-class facilities for catalyst and sorbent characterization:

- Brunauer-Emmett-Teller surface area
- Pore-size distribution
- Attrition resistance
- Scanning and Transmission electron microscopy
- Particle-size distribution
- Thermogravimetric analysis (including high pressure)
- Differential thermal analysis
- Differential scanning calorimetry
- Temperature-programmed reaction and desorption
- Inductively coupled plasma mass spectroscopy
- X-ray diffraction

## Membrane Development

RTI is developing advanced gas separation membranes and membrane-based processes for removing contaminants from industrial process gas streams, including gasification syngas and post-combustion flue gas. RTI has a dedicated team of researchers and state-of-the-art lab facilities to carry out the synthesis, characterization, and evaluation of membrane materials and processes. RTI has also developed in-house membrane process simulation software for modeling multi-component gas separation processes.

RTI has in-house expertise and the facilities needed for membrane synthesis, characterization, and testing. Our membrane permeation testing facilities are well-equipped for determining gas permeances and selectivities of planar and tubular, polymeric and inorganic membrane materials and modules over a wide range of operating conditions and gas environments. RTI's membrane testing facilities also allow the determination of the long-term effect of realistic gas environments on membrane performance. The range of test conditions include:

- Multi-component gas mixtures at high pressures (up to 1,500 psia) and high temperatures (up to 350 °C)
- Toxic and corrosive gases (CO, $H_2S$, $CO_2$, $SO_2$, etc.)
- Humidified gas mixtures.

## Materials Scale-up and Commercialization

RTI maintains a philosophy of adapting commercial and scalable production practices early in the catalyst, sorbent, or membrane development process. We maintain close relationships with the major commercial catalyst and membrane manufacturers. This approach results in the straightforward and rapid scale-up of a majority of materials developed at RTI.

## Doing Business with RTI

We work closely with commercial, government, and academic partners to maintain a portfolio of innovative energy technologies with a high potential for commercial success. Strategic alliances with industry partners ensure that economic and technical feasibility are part of our thinking from initial concept through to the development stage. Our focus is on joint development activities, but we also provide commercial clients with specialized research and development, testing, and analytical services.

**More Information**

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