Nanomaterials Integration and Development

Nanotechnology offers the potential to solve some of humanity's most vexing challenges and is a critical driver of future economic growth worldwide. With its broad range of prospective uses, nanotechnology offers the promise of transformational change in virtually every industry, from aerospace and energy to healthcare and agriculture. RTI International's nanomaterials research focuses on the preparation, functionalization, characterization, and integration of nanoparticles and nanofibers into high-performance materials.

Overview

The value of nanomaterials stems from the innate properties generated as particle size becomes smaller and the surface area to bulk ratio increases dramatically. Higher surface areas lead to a marked improvement in performance of materials used in various applications, including catalysis, energy storage, high-strength materials, and light manipulation.

RTI possesses the capabilities to generate and functionalize nanomaterials of a range of properties to meet a variety of client needs. The physical and chemical properties of nanomaterials can be tuned to enable specific applications. These properties can be controlled synthetically, producing a range of possible particle shapes and sizes, including quasi-spherical nanoparticles, nanofibers, nanoplates, nanorods, and core-shell nanomaterials. Particle morphology can be used to tailor charge transport properties, porosity, and surface area. The surface of nanomaterials can also be functionalized with stabilizing ligands, ionic agents, chromophores, redox-active species, and catalysts in order to modify properties and function.

Value-Added Applications

The unique properties of nanomaterials are being exploited by commercial, government, and academic laboratories to add value to existing products and to enable entirely new product development opportunities. RTI has demonstrated capabilities to tailor size, shape, and morphology to achieve performance gains in target applications. RTI is currently focusing on generating and integrating nanomaterials into systems for applications in energy production and efficiency, optics, electronics, biomedical, and advanced materials.

Property	Application
Optical	Solid-state lighting
	Light management (redirection, scattering, and antireflection)
Tailored surface area	Photocatalysis for environmental remediation, self-cleaning
	Photoanodes and photocathodes
	Self-cleaning and superhydrophobic surfaces
Mechanical	New structural composites (stronger, lighter)
	Cementatious materials
Electrical	Nano-based sensor technology
	Printed electronics
Biomedical	Controlled-release formulations
	Filtration
	Novel composites for medical devices

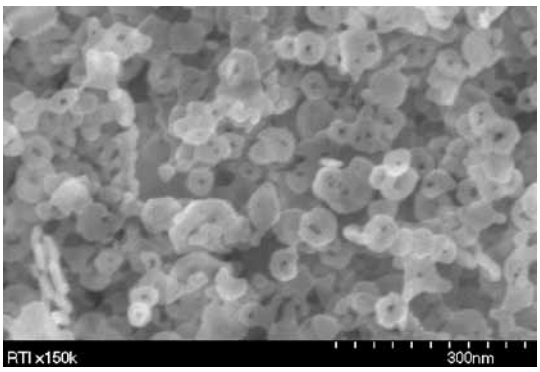
Nanomaterials Synthesis and Integration

RTI has a variety of synthetic methods at its disposal for producing nanoparticles, tubes, fibers, and other nanostructures. These include

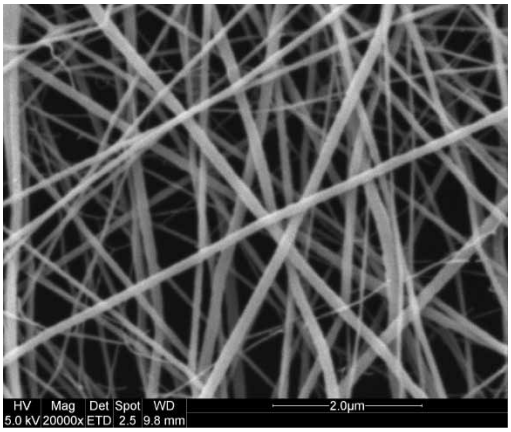
- Solution-phase fabrication (emulsion, microemulsion, precipitation)
- Electrospinning for multifunctional polymer, ceramics, and composite materials
- Aerosol and dry powder methods
- Physical and chemical vapor deposition
- Soft lithography and nanoembossing
- Sol-gel methods
- Ink-jet deposition
- Electrochemical methods
- Self-assembly/layer-by-layer fabrication

RTI is expert at integrating and functionalizing nanomaterials. We also develop formulations for incorporating nanomaterials into devices and applications. Pertinent methods include

- Ink-jet printing
- Chemical bath deposition
- Dip, spray, and spin coating methods
- Continuous roll coating and patterning methods
- Electrodeposition
- Screen printing
- Coaxial electrospinning



Donut-shaped nickel oxide nanoparticles are fabricated for an energy generation application.



By significantly increasing the surface area over conventional fibers, nanofiber films can exhibit the unique functions attributed to the fiber surface, enabling advanced materials for multiple applications.

Nanomaterials Characterization

RTI has access to a host of characterization methods for assessing and quantifying properties, nanomaterials, and products containing integrated nanomaterials. Our combined synthetic and characterization facilities allow for rapid production, evaluation, screening, and optimization of materials and processes for application-specific use. A sampling of our analytical capabilities includes

- Electron and optical microscopy
- X-ray structural and chemical analysis
- Surface characterization
- Particle analytics
- Polymer characterization
- Chemical and electrochemical analysis

More Information

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