Center for Metamaterials

Advancing fundamental and applied metamaterials research, development and technology transfer via strong industry/university collaborations.

Logo

Collaborating Institutions

The City University of New York

University of North Carolina Charlotte

Clarkson University

Western Carolina University

Center Mission and Rationale

Metamaterials are patterned composite materials in which light behaves in unusual ways, including negative index of refraction, anomalous light transmission, and light channeling and trapping. Industry interest in metamaterials is growing as these materials are being used to develop new or higher performing optical and electronics devices including: energy harvesting, imaging, plasmonic circuits, cloaking materials, biological and chemical sensors, compact optical systems and enhanced RF technologies.

The Center for Metamaterials's mission is to provide a one-stop shop for the design, fabrication and testing of a wide range of metamaterials for use in spectral regions ranging from the microwave to optical part of the electromagnetic spectrum. The researchers at the Center focus on research topics jointly identified by the university and industry participants as being of high value and include fundamental research, metamaterials processing, and device development and technology transfer. The projects advance knowledge through precompetitive research that will

directly benefit a significant number of Center members through shared knowledge and intellectual property. The intent is also to nurture long-term relationships and collaborations amongst the universities, industries and government labs that are participating the Center.

Example Research Projects

The research thrusts of the Center of Metamaterials include:

1. *Sustainable Energy Technologies:* Solar cells, transparent electrodes, light harvesting templates, concentrators.

2. *Sensors:* Polarimetric and nonpolarimetric, multiwavelength detectors, focal plane arrays, biological and chemical sensors.

3. *Microwave and THz Technologies:* High permittivity materials, extreme anisotropies, field enhancements, increased detector sensitivity, low observable structures

4. *Optical Components:* Perfect lenses, micro-polarizers and polarizer arrays, beam shaping, active optical components, cloaking and camouflaging materials

For each of these research thrusts, research from fundamental research, design, modeling, fabrication and testing will be performed as described below:

- Design/Modeling/Simulation – Fundamental properties of metamaterials are studied and applied to particular applications. Design and simulations are performed using several tools and techniques including: Ansys HFSS, COMSOL, Sonnet Software CST Microwave Studio and proprietary rigorous couple wave analysis.

- Fabrication – Metamaterials and devices are fabricated by at laboratories at UNCC, CUNY, Clarkson and WCU. Fabrication tools at these universities include tools for nano & microfabrication, CNC machines, 3D printing machines and other rapid prototyping machines.

- Testing – WCU, UNCC and CUNY all have advance optical testing facilities that perform optical characterization from the UV to microwave spectral ranges.

Special Center Activities

In addition to the research activities, the Center works closely with the following four organizations that support industry/university collaborative research and development projects with the mission of generating economic impact to the regions in which they are located:

1. Center for Advanced Technology in Photonics Applications at CUNY (Director: David Crouse)
2. Center for Advanced Materials Processing at Clarkson (Director: S.V. Babu)
3. Center for Optoelectronics and Optical Communications at UNC (Director: Michael Fiddy)
4. Center for Rapid Product Realization at WCU (Director: Dr. Phil Sanger)

Center affiliates participate in defining research projects, participate in workshops and educational training sessions and have access to faculty, staff, students and facilities at all four universities. Membership of the Center brings many benefits including networking and other funding opportunities.

Facilities and Laboratories

Design and Modeling Facilities

- The CUNY CAT Photonics Design and Modeling Facility – Equipment at this facility includes a 10 node high performance computing cluster with the following photonics modeling programs: Ansoft's HFSS, Sonnet Software's CST Microwave Studio, Zemax, Silvaco Atlas, and COMSOL.

Fabrication Facilities

- Clarkson, WCU and UNC Charlotte all have fabrication facilities that perform rapid prototyping of metamaterials that operate throughout the UV to microwave spectral regions.
- Center for Optoelectronics and Optical Communications includes a 4000ft^2 class 100 and 1000 clean room with a wide range of optical device fabrication equipment.
- Center for Rapid Product Realization – Includes rapid prototyping machines such as Haas CNC machines.

Testing and Characterization Facilities

- The CUNY CAT Photonics Testing Facility – Has numerous lasers, light sources, monochrometers/spectrometers, sensors, FTIR, and an anechoic chamber to perform optical characterization from the UV to microwave spectral region.
- The UNC Charlotte Facilities – equipped with all the optical tools necessary to optically characterize materials as well as the recently graduate I/U CRC Center for Precision Metrology.

Center Locations and Contacts

CUNY

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The City University of New York

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Clarkson University

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