Center for Metamaterials (CfM)

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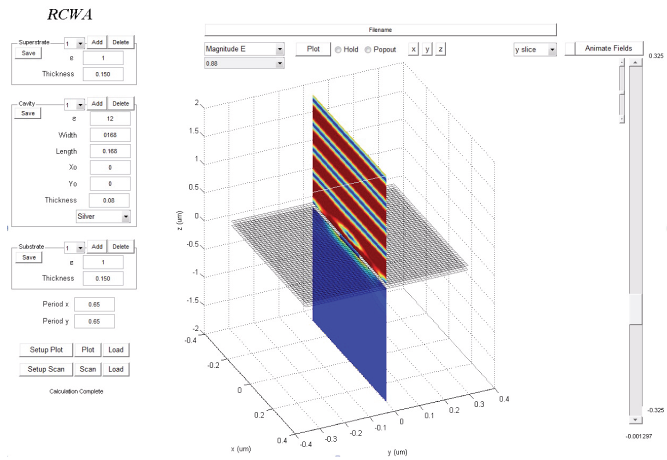
Fast, Flexible, and Accurate Algorithms for Metamaterial Device Design

Optical modeling tools are essential in efficient development of new photonic, plasmonic, and metamaterial devices for a wide range of applications, including optical and infrared sensors, imaging systems, solar cells, and other renewable energy devices. These tool applications are important to almost all CfM member companies. Unfortunately, all commercially available modeling and design programs have significant shortcomings in that they are slow, not user-friendly, and are prone to errors when used to model realistic metamaterial structures and devices. The commercially available programs lack the ability to simulate situations that would be encountered in real-life situations and have limited ability to test the metamaterials when exposed to complex light and radiation patterns. Bottom line: with existing programs it is difficult and time consuming to extract the desired information from the modeling results.

Fast and accurate optical modeling tools are essential in efficient development of new devices for a wide range of applications, including optical and infrared sensors, imaging systems, solar cells, and other renewable energy devices.

Researchers at CfM are addressing these limitations by developing new programs and algorithms specifically designed to quickly and accurately model metamaterials. These algorithms improve the speed of modeling and simulation, provide better accuracy, and organize the data in the ways desired by photonics scientists and engineers. This CfM research project has received much sponsor interest. Soon the program will be at a state where it can be distributed to the other member companies of the CfM. This project is ongoing and the program will be continually developed to add additional capabilities and improve its speed and ease of use.

There are several advantages of this software. First, the program improves the speed of modeling metamaterial and optical devices by a factor of 10,000 relative to existing commercially available programs. Second, it can be more accurate for designing realistic optical materials. Third, it is easy to add-on design optimization functions, scans of radiation patterns, and coupling the optical modeling to electrical and thermal modeling programs. These advantages represent a breakthrough in metamaterials modeling and design. Early versions of the software are already being tested and used by one of the CfM member companies, Phoebus Optoelectronics, to model and design an optical sensor for NASA and other projects funded by the US Army and DARPA. Phoebus is using this program to take advantage of its capabilities of scanning hundreds of possible device structures to finalize device designs.



The RCWA Modeling Program from the Center for Metamaterials. This application models and analyzes several types of optical materials and offers quick graphical construction and easy data extraction. The core algorithm is fast, accurate, and employs different approximations depending on the desired speed and accuracy of the output and structure's nature.

Economic Impact: The expected economic benefit of this breakthrough technology will reduce design and development time for new photonic, plasmonic, and metamaterial devices. These can now more easily be applied in a variety of research, commercial, and defense applications. Examples of these applications include high efficiency solar cells and other renewable energy devices (hydrogen and methanol generation devices), advanced optical sensors and imaging systems, ultra-high bandwidth communication devices, and optical coatings for cloaking, stealth, and electromagnetic shielding. The resulting improvements in design and development efficiency should ultimately reduce product costs thereby enhancing the competitiveness of American industry in the global marketplace.

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