RSOFT Design Group
REVIEW
JANUARY-JUNE 2007 RSOFT DESIGN GROUP
VOLUME 6
NUMBER 1

Modeling Surface Plasmon Biosensors

Surface phenomena such as surface plasmon resonances play an important role in sensor technology since the behavior of electromagnetic fields at material interfaces can be directly correlated to many physical and chemical properties of the materials. These sensing methods have the further benefit of allowing for accurate and non-invasive sensing that can provide immediate results both in and out of a laboratory. Sensors based on surface plasmons are being increasingly incorporated directly into larger systems to detect many properties, including temperature and the presence or concentration of particular compounds in medical, industrial, or other fields.

The need to incorporate optical sensors into a wide variety of applications necessitates the creation of smaller sensors that are easy to fabricate with and used in existing semiconductor technology. However, as the size of any optical device, including sensors, decreases, the need for simulation software increases. RSoft's software tools, specifically FullWAVE, can be used to accurately model the electromagnetic fields at material interfaces where surface phenomena such as surface plasmons occur. FullWAVE provides a full-vector solution and allows optical design engineers to use complex material definitions, arbitrary device geometries, non-uniform grids, and sophisticated measurement techniques to create new sensor designs and fine tune existing designs for specific applications.

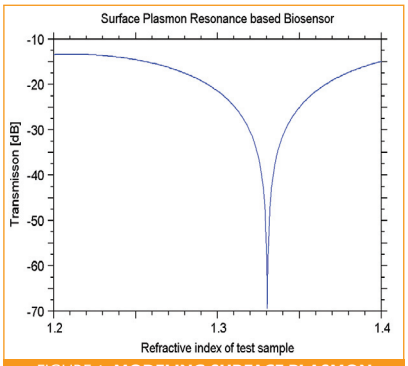


FIGURE 1: **MODELING SURFACE PLASMON BIOSENSORS**

As an example of the kind of sensor that could be modeled is described in Ref. [1]. It consists of a small interferometer in an SOI waveguide structure that functions much like a classic Mach-Zhender device. A small gold plate is embedded in the waveguide so that the material to be studied lies on top of the plate, and the silicon waveguide and oxide buffer layer lie below it. Light incident on the plate from the propagating mode in the SOI waveguide couples into two surface plasmon modes,

continued on page 2

Detailed Analysis of FFE, DFE and MLSE Electronic Equalization in Single- and Multi-mode Systems in OptSim 4.6

The 10GBase-LRM and the OIF EDC for 10 Gb/s 1550 nm Links projects use OptSim for detailed analysis of systems deploying Electronic Dispersion Compensation

Electronic Dispersion Compensation has recently gained attention as a cost-effective, power-efficient, small form factor solution to mitigate the effects of dispersion in single- and multi-mode fiber optical communication systems. Currently the 10GBase-LRM standard achieves 10 Gb/s operation over 300 m of FDDI-grade legacy multimode fiber using EDC at the receiver section. The Optical Internetworking Forum is working on a set of application codes to standardize for the ITU G.959.1 new optical links that use EDC to extend the reach of present Optical Transport Networks at 10 Gb/s with 1600 ps/nm of dispersion (80 Km of G.652 fiber) to 2400 ps/nm (120 Km of fiber).

The adoption of EDC, while a convenient solution to increase the network performance, has made it very challenging to analyze the interoperability between components. A link with a 10Gbps transmitter and a 10Gbps receiver with EDC doesn't necessarily create a 10Gbps system. The transmitter's compliance test should require estimation of its Transmitter Wavelength Dispersion Penalty (TWDP) in the presence of a Minimum Mean Squared Error

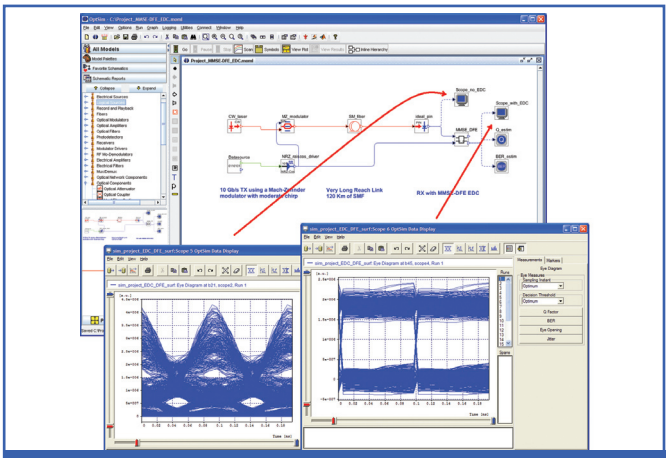


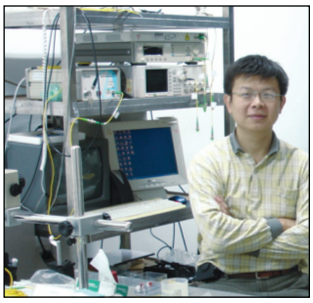
FIGURE 1 **OPTSIM PROJECT OF AN ITU G.959.1 SYSTEM DEPLOYING 120 KM SMF AND MMSE-DFE - EYE DIAGRAMS (A) WITHOUT EDC (B) WITH EDC.**

(MMSE) based Decision Feedback Equalizer (DFE) at the receiving end. This approach has been chosen by the IEEE 10GBase-LRM task force and is currently under investigation in the OIF EDC for 10 Gb/s 1550 nm Links project.

continued on page 2

Campus Corner

Cutting Edge Photonic Crystal Integrated Cicuits and Integrated Optic Device Research at the National Central University of Taiwan



CHII-CHANG CHEN

Associate Professor Chii-Chang Chen, Department of Optics and Photonics, National Central University of Taiwan, is an active teacher and researcher in the photonic crystal (PC) integrated circuit and integrated optic device area. The group's studies cover a very wide range of applications including PC directional couplers, negative refraction, GaN PC lasers, large-scale uniform self-assembled microspheres, PC lenses, hollow waveguides, directional emission from PC waveguides, PC beam splitters, solid immersion lenses in planar waveguide, SOI AWG, SOI MMI splitters, etc.

Professor Chen states: "We have two research teams: photonic crystal related devices and integrated optic devices. These teams often use multiple software tools in RSoft's Passive Device Suite together to provide a fast and rigorous solution: FullWAVE results can be used as the input to a BeamPROP calculation and the simulation results between FullWAVE and BeamPROP or between BandSOLVE and FullWAVE can be compared with each other to confirm accuracy. The GUI interface is friendly to use and the tutorials provided with the tools are very comprehensive. It takes students about two weeks to finish the tutorial exercises for each software package accelerating the output of our research. Additionally, since all the program files and the result files are in a simple ASCII format, it is very convenient to modify and reuse the files providing great research flexibility. We have found that the results from the RSoft tools match our experimental results which give us confidence that the RSoft tools provide a rigorous and precise method for studying PC and integrated optic applications."

Surface Plasmon Research at the Harvard Center for MIPS:Microfluidic and Plasmonic Systems.

Recent dramatic advances in surface plasmon (SP) technologies present new opportunities in MEMS/NEMS devices such as microfluidic systems. A new Center based at Harvard University was recently formed with the support and funding from industry groups and the Defense Advanced Research Project Agency (DARPA). The interdisciplinary academic/industrial team will carry out research on a new class of microsystems, known as MIPS: Microfluidic and Plasmonic Systems.

When Surface Plasmon (SP) nanostructures, which enable electromagnetic energy to be concentrated into deep sub-wavelength regions, are combined with microfluidic systems for sample delivery, the SP nanostructures present opportunities for significant increases in the detection sensitivity of biological molecules at very low concentrations. The accurate design of SP nanostructures is central to the activities of the Center. "We are very fortunate to have RSoft Design Group as an industrial partner for our Center," said Professor Ken Crozier, the director of the Harvard MIPS Center. "We have had much experience with various Finite Difference Time Domain (FDTD) simulations, and have found RSoft's FullWAVE to be very well suited for our particular needs," he added. Professor Crozier noted that FullWAVE allows metals of arbitrary shapes to be accurately modeled. "The RSoft team has been very responsive to our technical questions, and we look forward to continued interactions with them." Professor Crozier also noted that he has used RSoft products in his graduate class "ES275 Nanophotonics" since 2004.

Industrial partners include RSoft Design Group, Draper Laboratory, U.S. Genomics, LumArray, and Luminus Devices. Academic participants in the Center include Harvard, Harvard Medical School), and the University of Massachusetts at Amherst. The DARPA support is provided via their Microsystems Technology Office (MTO).

Communications and Optical Systems Research at the Military Engineering Institute (IME), Brazil

The Laboratory of Research on Communications and Optical Systems (LaRSO), at the Electrical Engineering Department of the Military Engineering Institute (IME) has multi-disciplinary research activities that focus on optical signal processing, optical communications performance evaluation, optical monitoring, and estimation systems.

LaRSO is a member of the Brazilian GIGA Project. This is a 600Km optical network provided for research experiments. The GIGA network interconnects 17 universities and research centers in the Rio de Janeiro-São Paulo area.

ROSÂNGELA COELHO

In 2003 LaRSO was the first university in South America that received the University Research Program (URP) from Cisco. The proposition was concerned with the optical contention performance study considering signals with fractal and non-fractal patterns.

Prof. Rosângela Coelho, Head of the LaRSO states, "Contention prediction and avoidance is an important challenge for packet switched systems. Optical contention and communications performance must be examined for different signal-patterns and statistics. Signal-patterns must represent real traffic distributions and statistical parameters. RSoft's OptSim design tool for Linux is a key enabler for our modeling and validation needs. It accurately estimates performance metrics such as BER, eye-diagram, etc. and helps us in the behavior verification of our optical pattern and packet generator (O2PG) module under a variety of real-life link design scenarios and noise statistics. Compared to the competing tools we evaluated, OptSim provided us with the most efficient modeling capabilities, intuitive GUI, support for Linux, prompt and excellent technical support, and presentation-friendly web-ready report creation features. We are happy to adopt OptSim at the LaRSO for all our research projects and classroom teaching purposes alike."

Advanced Optical Communication Device Research at Beijing University of Posts & Telecommunication

The laboratory of Optical Communications and Lightwave Technologies at the Beijing University of Posts & Telecommunications, is a leading laboratory for photonics research in China that is supported by the Ministry of Education in China. The laboratory actively pursues research in the areas of optoelectronic devices and microstructured optical fibers in order to develop technologies for next generation optical communications. Mr. Zinan Wang's group at the university uses BeamPROP to accurately model the propagation of light in various waveguides. Mr. Wang comments, "BeamPROP is a powerful tool. It is easy to use and very flexible for testing new design ideas. We look forward to bolstering a close cooperation with RSoft for our future modeling needs and projects."