CMC MICROSYSTEMS IMPACT

# Photodetector for biomedical applications takes semiconductor technology to a new level

Université de Sherbrooke doctoral candidate, Thierry Courcier, is developing a lab-on-a-chip to detect very low-level signals of multiple fluorescence sources for biomedical applications. His research, involving close collaboration with Teledyne DALSA, a Canadian semiconductor foundry, has led to novel technology developments and a valuable graduate-level training experience. Courcier credits CMC with providing the CAD tools to design the device and the electronics, and for providing access to fabrication that made the project possible.


The lab-on-a-chip research undertaken by Université de Sherbrooke doctoral candidate Thierry Courcier (above) is an example of a multi-disciplinary, university-industry project, mediated through CMC Microsystems, that has resulted in novel technology development and valuable international research experience for the student.

Courcier is a member of the Biophotonics and Optoelectronics Laboratory, led by Drs. Paul Charette and Vincent Aimez. The lab has a number of interdisciplinary projects underway that involve the development of specialized instruments for studying biological tissues and systems. Their work combines photonics, electronics, material sciences, signal analysis, biochemistry and medicine.

An important focus for Courcier has been the development of a lab-on-a-chip equipped with a miniaturized four-channel spectrometer—a unique photodetector. The tiny device uses microfluidic channels to direct a sample above the photosensitive area, where it measures the optical intensity of fluorescent labels that are attached to molecules and excited by a laser. Then, the concentration of four molecules is simultaneously deduced from the photocurrents provided by the four stacked p-n junctions of the spectrometer, p-n junctions being the active sites where the electronic action of a semiconductor device takes place.

Current systems, including fluorescence microscopes and cytometers, require expensive and large optics to select one target at a time. Unlike those systems, the chip-based spectrometer he is developing doesn't require any optical filter dedicated to the selection of fluorescent wavelengths, according to Courcier.

Fluorescent tags can be easily attached to genetic sequences, proteins, antibodies or amino acids and are an important tool in molecular biology and biotechnology. Courcier's new device could be used for inexpensive and rapid genetic testing, either at home or in a doctor's office. It requires only a small drop of blood and could detect viruses and measure a patient's immune system response from a single sample.

In many cases, the concentration of one type of virus might not be sufficient to make a diagnosis. Sometimes, you need to know the relative proportion of other viruses. "The quad-junction photodetector will allow for more complex kinds of testing," says Courcier. "With this system, you can measure four molecules at the same time in the same place." The research team wanted to develop a lab-on-chip built entirely using Teledyne DALSA's high-voltage 0.8-micron CMOS technology. The technology is commonly used to actuate microelectromechanical systems (MEMS). But Courcier, working with the company and CMC Microsystems, created an intriguing technology "perversion" by using it to design photodetectors—an innovation that takes the technology beyond its original purpose.

"The Teledyne DALSA semiconductor high-voltage CMOS process allows us to create the photodetector, but also the dedicated electronics necessary to improve sensitivity and perform the signal processing. And for high volumes, costs in this technology are lower than other process options", he says.

Courcier, who is completing a joint doctorate at the Université de Sherbrooke and Université Claude Bernard Lyon 1 in France, expects to complete his PhD in the coming year. *cmc*

 