LifeSciTrends
Exploring Technologies that Change the Way We Live
November 2010

NSF Mid-Infrared Center at Princeton University Breathes New Life Sciences Applications

BY JOSEPH MONTEMARANO

These two photographs of the "Bird's Nest" Olympic Stadium in Beijing are examples of "good" and "bad" air quality day comparisons.

The ability to routinely make precise "trace-gas" measurements – at parts-per-million (ppm) or parts-per-billion (ppb) sensitivity – for promising applications in health, environment and homeland security requires compact footprint, portability, tunability, sensitivity, low power consumption, speed, ease-of-use and affordability. While complex laboratory equipment like mass spectrometers is used today to measure trace gases with high precision, it is also true that widespread deployment of such systems is limited by their large size, high cost, stringent operator requirements and many other factors.

The National Science Foundation Engineering Research Center on Mid-InfraRed Technologies for Health and the Environment (MIRTHE), headquartered at Princeton University, seeks to advance technologies, systems and testbeds that will take high-precision trace gas sensing from complicated and expensive laboratory systems to compact, easy to use devices, inexpensive enough to be widely deployed. It is doing this through its core and innovation breakthrough research projects and working in close collaboration with industry, government and academic partners City College of New York, Rice University, Texas A&M University, The Johns Hopkins University, and University of Maryland at Baltimore County.

MIRTHE also has launched an Investment Focus Group aimed at introducing investment and industry professionals to these emerging technologies and application opportunities in the health and environment sectors. (See Capital Corner)

MIRTHE designs novel Quantum Cascade Lasers (QCLs) – an innovation originating almost two decades ago in New Jersey at Bell Labs – at wavelengths across the entire mid-infrared range to address key market and societal needs, especially for hospital, doctors' office, and in-home use of portable, non-invasive, real-time monitoring of patient breath and tissue in early and on-going diagnosis and treatment of organ failure, metabolic diseases including diabetes, early cancer detection, and environmental health.

What's so special about the mid-infrared?

Molecules are uniquely identifiable through their mid-infrared absorption spectra due to strong resonance lines between three and 30 microns for low detection limits down to the sub-parts-per-billion sensitivity level. Also, optical measurements are fast, non-invasive and non-destructive. For example, gaseous ammonia (NH3), an important indicator of impaired liver or kidney function, can be detected far more readily in the mid-infrared than by using light from other parts of the spectrum.

MIRTHE Scientific Advisory Board member Raed Dweik of the Cleveland Clinic uses the term "breath-print" to describe the unique nature of thousands of chemicals in expelled breath and offer important insights into "personal" medicine. (R.A. Dweik, A. Amann, J. Breath Res. (2008) 030301.)

Global debut of prototype mid-infrared systems

Equally important as recent QCL advances, MIRTHE is pursuing novel detector designs, signal and data processing, and full systems integration and deployment of prototype sensor systems in sensor networks. In a very short time, the Center has taken the latest laboratory advances into the field through testbed demonstrations and close cooperation with its industry partners.

MIRTHE successfully deployed two prototype air quality monitoring systems near Olympic City venues during the 2008 Summer Olympic Games in Beijing. The comparison of "good" and "bad" air quality days (shown in the photo of the

iconic "Bird's Nest" Olympic Stadium) highlights the challenging environment in which these systems operated, and suggests less-than-subtle human health monitoring applications from an environmental health perspective. Careful analysis of the data collected (with good spatial and temporal resolution) during nearly three months of continuous pollution monitoring of this urban environment by MIRTHE's systems may provide insights into why there were many more "good" air quality days than anticipated. It also may shed some light on the effect of human activity on local air quality, even for a relatively short period of time. One of MIRTHE's systems has recently been deployed in a remote coastal village in Ghana.

MIRTHE is also working on compact wireless sensor network systems that can quickly integrate improved sensors from different companies. A MIRTHE post-doctoral researcher at Princeton University has recently established a start-up, Sentinel Photonics, to commercialize low-power chemical sensors optimized for wireless sensor networks targeting applications in atmospheric sensing, process monitoring and medical exposure (see photo).

The center is conducting an early clinical trial for monitoring ammonia and carbon dioxide with 0.1 second resolution in human breath at St. Luke's Hospital in Bethlehem, Penn. This breath monitor provides detailed information about the exhaled breath cycle and includes a laser system manufactured by Hamamatsu Corporation of Bridgewater. MIRTHE industry partners span several market sectors and range in size from the earliest of start-ups to major global corporations to speed the transition of technology and discoveries out of the lab and into everyday use.

The Center's efforts are evidenced by a growing number of New Jersey start-ups employing mid-infrared technology, including Feather Sensors in Millville, whose application combines breath sensor measurements with air velocity and auditory vibration emanating from the lung, and PTAC, a Princeton-based medical diagnostics company. ■

Joe Montemarano is the executive director of the MIRTHE Center at Princeton. For a list of MIRTHE industry and non-profit/practitioners and additional information about MIRTHE, visit www.mirthecenter.org.

MIRTHE Investment Focus Group Aims to Reward Innovation

BY MORTON COLLINS

As the development of MIRTHE technology progresses, it will spawn more spin-outs. These companies must be financed at the start and continue to be supported as products move from prototypes to commercialization.

Given the current economic climate, securing the required financing is particularly challenging. Historically, such start-ups have been financed principally via venture capital. However, during the past decade, venture capital has, for a variety of reasons, produced significantly lower returns than most other investment indices. This situation has initiated a secular decline in the venture capital industry, significantly reducing the capital available for early-stage companies.

Formerly, Initial Public Offerings (IPOs) and Merger & Acquisition transactions (M&As) have been the most widely used paths to liquidity for venture-backed companies. However, the past five years has seen a substantial reduction in the number of such transactions, which is one of the factors contributing to the decline in returns for the venture-capital industry. While the past two calendar quarters have provided a modest upturn, valuations of the companies for which transactions have occurred has been quite low by any historical standard.

Noting the potential difficulty in financing MIRTHE technology spin-outs, MIRTHE formed an Investment Focus Group (IFG), whose broad goals are to reward the most innovative ideas to drive technology commercialization and entrepreneurship arising from MIRTHE technologies and to encourage collaboration amongst various stakeholders. These include universities, entrepreneurs, investors, private sector companies, government agencies such as NSF, NIH, EPA, DOE, DOD, Department of Commerce, state/local government EDAs, and relevant non-profit institutions.

More specifically, IFG's mission is to foster the introduction of venture capital, angel and other investment professionals to mid-infrared technologies and application opportunities. It does so by enabling investor exposure to MIRTHE member firms, both small and large, by presenting opportunities to nurture MIRTHE-related start-up companies, by providing joint assessment of technology readiness and approaches to commercialization, and, by educating both students and the broader academic community about entrepreneurship and technology commercialization.

IFG's expanding 20-member board represents venture capitalists, angel investors, state agencies, entrepreneur networks, universities, industry support organizations, commercial banks experienced with early stage companies and other groups actively involved in the spin-out and commercialization process. This group facilitates the solution of problems facing the early-stage companies leveraging new technology developed at MIRTHE. ■

Morton Collins is a general partner of Princeton-based Battelle Ventures.