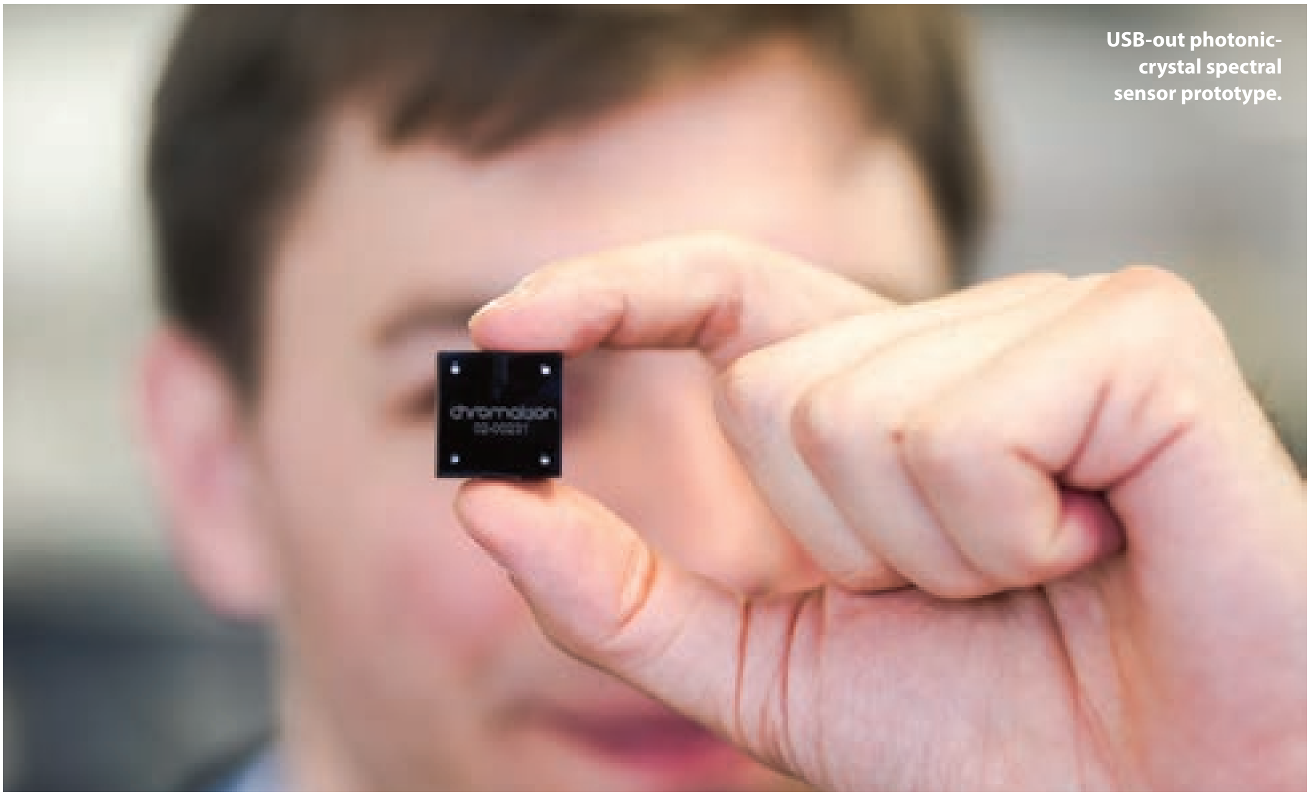


USB-out photonic-crystal spectral sensor prototype.

Photos by © Ruby Tull Photography

OPTICS INNOVATIONS

# Rethinking Consumer Spectroscopy

Chromation is bringing spectroscopy to consumer electronics with innovative technology that opens a path to a chip-scale spectrometer.

Nadia Pervez and Ioannis Kymissis

Projects sometimes take an unexpected path. Chromation's story began in 2009 at Columbia University, N.Y., USA, when one of the authors (Pervez) was working with the other (Kymissis) on a project using photonic crystals. The project's goal was to enhance brightness in top-emitting OLEDs on CMOS. To speed up development of the fabrication process, we tried a glass slab simulant with the photonic-crystal designs under test to mimic the OLED seal and passivation layers, assessing the performance via the photonic crystal's scattering of waveguided light. The light scattering was spectrally selective, and it quickly became apparent that the simulant structure could be used to make an extremely small, simple spectrometer.

Chromation was founded to take that technology off of the optical table in the university lab and turn it into a commercial product. With the support of the U.S. National Science Foundation, Chromation began operation in 2011. Today, the company's spectral sensors bear little resemblance to that initial experimental setup in the lab. Its engineering efforts have focused on developing manufacturable processes for our photonic-crystal components, creating an optical design that simplifies assembly, and providing a path toward a chip-scale solution.

## The technology

Chromation's spectral sensors are small components with a broad UV/VIS/NIR range appropriate for a wide variety of molecular spectroscopy applications. They combine two proprietary design elements: photonic-crystal scattering to create spectral selectivity; and integrated light management through optical features fabricated on the same substrate as the photonic crystal.

The former offers key benefits such as a parallel substrate-to-detector alignment for simplified assembly, strong dispersion, a small nanostructured interaction region, and fabrication via optical lithography in a high-volume CMOS-compatible process. The latter provides a means to manage unwanted (stray) light. That takes the burden of numerical-aperture matching and the addition of related coupling optics off of design engineers, allowing them to focus on their applications.

This approach differs from that of competing products using micro-gratings or linearly variable filters, which are more like miniaturized versions of conventional laboratory instruments. The Chromation design allows systems to be smaller and reduces integration complexity for users. The low cost and small size of the company's components allow for integration into low-cost handheld systems that bring quality spectral measurement out of the laboratory and into consumer applications.

The Chromation design allows systems to be smaller and reduces integration complexity for users.

## The business model

One of the questions that we had to address early on was whether Chromation should build complete sensor systems (for example, light or color meters) or build components for integration by our customers. After exploring a number of target application areas and investigating the barriers to entry for new instruments, it became clear that an OEM model, in which we work closely with partners established in each market area, made a lot of sense. This allows the company's team to focus on technology development while leveraging our customers' expertise within their markets.

The Chromation team has been engaged in customer discovery activities and getting feedback on evaluation units to inform the company's product roadmap. This process has yielded a number of pioneer customers, and we have been working on distributing development kits, building demonstrators, working on joint development programs, and piloting the system in applications relevant to these customers' problems in a variety of spaces in which a handheld, low-cost and even disposable spectral detection systems could provide value. Chromation is also in a pilot production run with a design and assembly house to establish the supply chain and develop metrics and a quality program for future assemblies.

## The future

While Chromation's spectral sensors allow for extreme miniaturization and the elimination of external optics in many applications, one benefit of the company's technology approach is its scalability to single-chip integration, in which the spectrally selective elements and the numerical-aperture-limiting components are integrated into a linear detector's cover glass. Chromation's technology roadmap includes a plan for further size reduction to integrate the photonic crystal and detector into such a single-chip package, to address the needs for integration into small form factors such as wearables and mobile devices.

The production efficiency and low cost for the single-chip version of the component should provide the economies and scale required to support diverse markets for wavelength-resolved spectroscopy, at a price point and format currently limited to RGB sensors. Such a system can unlock a variety of applications in embedded electronics, health monitoring, wearable devices and color management. OPN

Nadia Pervez (nadia@chromationspec.com) and Ioannis (John) Kymissis are the chief executive officer and chief technology officer of Chromation.

Photonic crystal die

### COMPANY INFO

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### WHY NEW YORK?

Its Harlem location gives Chromation convenient access to resources at Columbia University and the City University of New York's Advanced Science Research Center.