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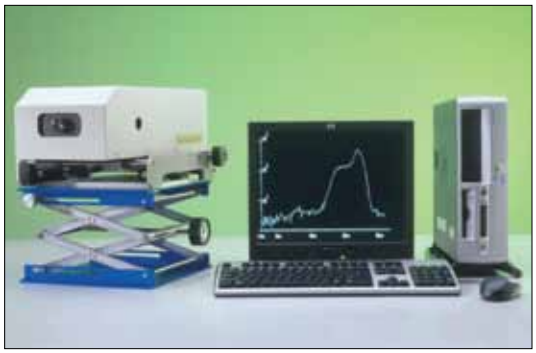
Seeing inside the eye with fluorophotometry

In the early 1980s, the Palo Alto-based medical division of Coherent, Inc., developed the Fluorotron Master, a fluorophotometer used to quantify fluorescence inside the human eye. The device was originally intended to operate similar to fluorescein angiography, by indicating the leakage of fluorescein dye from the retina into the vitreous.

Decades later, it has evolved into a laboratory device that is used much differently than fluorescein angiography. Whereas fluorescein angiography is more visual, fluorophotometry provides quantitative measures of fluorescein concentration that are versatile enough to indicate subtle changes in the health of the retinal blood vessels, retinal pigment epithelium, choroid and ciliary processes.



Now researchers around the world use the Fluorotron to detect blood-retinal barrier breakdown in diabetes, cornea and lens autofluorescence in diabetes, blood-aqueous barrier breakdown in uveitis, aqueous turnover in glaucoma, tear turnover and volume in dry eye, corneal endothelial permeability after corneal surgery, and corneal epithelial barrier function when contact lenses are worn.

The transition of the device began in March 1993, when Bruce M. Ishimoto, MS, founded OcuMetrics, Inc. to focus on the advancement of the Fluorotron Master. "I had been one of the engineers who helped develop the Fluorotron at the medical laser company Coherent," Ishimoto remembers. "Although they had developed the Fluorotron to be something they could sell with lasers, it turned out to be a smaller research market than the clinical market they had intended. It seemed like the perfect device for a small business to cultivate."

Because the device had initially been built for use in humans in the clinic, Ishimoto's team first developed a new version that was adapted for basic research involving laboratory animals. Today, OcuMetrics' stable of devices includes the laboratory animal version (which can be used on rats and larger animals), a human version and a new version that can be used on mice in the laboratory.

"The Fluorotron is a scanning ocular fluorophotometer — actually, the only commercially available scanning ocular fluorophotometer," Ishimoto explains. "It is used in a wide range of

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ARVO Medical Devices Exhibitors

In the Lab: the Fluorotron Master

At the University of California, Berkeley, Meng Lin, OD, PhD, FAAO, has been using OcuMetrics' Fluorotron for several years to study human corneal epithelial barrier function.

"The instrument allows us to determine the penetration rate of fluorescein molecules into corneal tissue from pre-corneal tear film," explains Lin, who is director of the university's Clinical Research Center. "With this measurement, we have published data on how corneal epithelial permeability differs by ethnic groups. We were also able to propose possible mechanisms to explain how corneal epithelial barrier function is altered during contact lens wear."

Carol B. Toris, PhD, professor and director of glaucoma research at the University of Nebraska Medical Center, uses five fluorophotometers in her studies: two for humans, one for nonhuman primates, one for rabbits and the new model for mice.

"The Fluorotron Master fluorophotometer is the mainstay of our research," she says. Toris explains that her team scans the cornea and anterior chamber after administering topical fluorescein, measuring the fluorescein's disappearance rate over time. Using that information along with cornea and anterior chamber volumes, she is able to calculate the

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flow rate of aqueous humor into the anterior chamber.

"We use the fluorophotometers to measure aqueous flow before and after drug treatments, during the day and at night, in various ocular syndromes that elevate intraocular pressure, and in different age groups," Toris says. "This is the only commercially available instrument to measure aqueous flow." ■

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ophthalmic research, but because it's not used in the clinic often, many ophthalmologists know relatively little about it."

The device – composed of an optic head, computer, display monitor and printer – can produce 149 measurements of fluorescein concentration (in nanograms per milliliter) along the optical axis of the eye, from the retina to the cornea. This is made possible by an excitation beam of blue light shined into the eye after an intravenous injection or eyedrop application of fluorescein tracer dye. The fluorescent green light produced is directed into a photodetector.

"Our fluorophotometer has broad applications, so it can be shared among a team of researchers," Ishimoto says. He finds that many researchers and drug companies are using it for drug discovery, validating drug compounds and looking for complications of contact lens solutions.

"We can make modifications to the machine that tailor it to addressing a specific customer's needs."
—Bruce Ishimoto

"What keeps me going is that nearly every one of my customers is doing something different," Ishimoto explains. "As a small company, we can respond to that. We can make modifications to the machine that tailor it to addressing a specific customer's needs. Yet at the same time, it has the advantage of being a standard machine that is sold with basically the same optics between the animal and human versions. Its measurements are very reproducible and can be replicated elsewhere." ■