

OCT Imaging: Enhancing Eye Care with Advanced Technologies

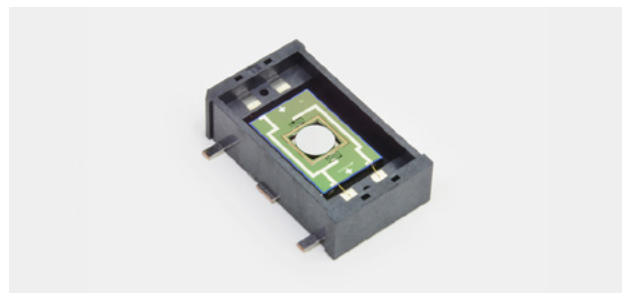
With the increasing use of digital devices, eye care has become a critical health priority due to issues like digital eye strain, macular degeneration, and glaucoma. In response, Optical Coherence Tomography (OCT)^[1] has emerged as a vital tool in ophthalmology, enabling clinicians to capture high-resolution, cross-sectional images of the retina and other ocular structures. OCT's non-invasive imaging aids in the early detection and management of eye conditions that traditional methods, like fundoscopy, often miss. This technology allows for precise analysis of the retina and optic nerve, helping diagnose conditions like glaucoma, diabetic retinopathy, and macular degeneration before symptoms appear, making it indispensable in both clinical and research settings.

The Role of Mirrors in OCT Systems

OCT imaging relies on mirrors to direct and focus light onto the eye's internal structures, essential for obtaining comprehensive 2D or 3D images. Piezoelectric mirrors, known for precision, struggle with manufacturing large 2D linear mirrors, limiting their application in broader scans. Electrostatic mirrors, though efficient and precise, face challenges in scaling to larger sizes. However, they remain popular due to their ability to produce high-quality images. Electromagnetic mirrors, such as MEMS mirrors from Hamamatsu Photonics, are capable of being produced in larger sizes and offer a promising solution, enhancing OCT systems' capability to capture larger retinal or optic nerve areas. This improves diagnostic accuracy and provides detailed images, especially in advanced eye conditions.



Hamamatsu's MEMS mirror S13124-01.



Hamamatsu's IMEMS mirror S12237-03P.



Scanner Requirements for Effective OCT Imaging

OCT scanners must meet specific requirements to deliver accurate, detailed images. Key features include 2D scanning capability for capturing cross-sectional images of the retina, essential for detecting conditions like macular edema or glaucoma. The scanner should have an adjustable scanning angle for versatile imaging of different eye regions. Fast scanning speed is crucial for broad-area scans, improving patient comfort and operational efficiency. Large mirror sizes ensure proper focus and light precision, covering wider areas for accurate diagnosis. These features enable OCT systems to provide comprehensive imaging, vital for diagnosing and monitoring conditions like glaucoma, diabetic retinopathy, and macular degeneration.

Trends in OCT Instrumentation

The landscape of OCT technology is evolving to cater to different healthcare settings, reflecting the diverse needs of patients and healthcare providers. High-end OCT machines are typically found in university hospitals, where they provide advanced diagnostic capabilities for in-depth examination of complex eye conditions. These systems are equipped with cutting-edge mirror technologies and fast scanners to ensure high-

resolution imaging, enabling clinicians to detect subtle changes in the retinal layers that could indicate the early stages of diseases such as macular degeneration or diabetic retinopathy.

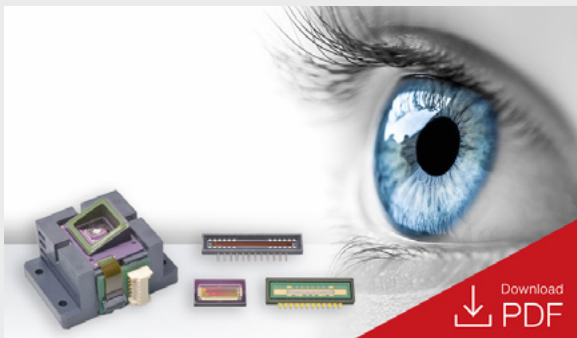
On the other hand, middle-end machines are available in clinics, offering reliable diagnostic tools for general practitioners. These systems provide good-quality imaging but at a more affordable cost. The performance of middle-end machines is sufficient for routine eye exams and monitoring patients with less complex conditions. In contrast, low-end OCT machines are becoming increasingly common in optician offices or community health centers. These compact and affordable systems facilitate quick, preliminary eye exams and screen for common eye conditions such as glaucoma or macular degeneration. They offer an alternative for patients who may not have access to high-end machines, ensuring that basic eye care is available to a broader population.

The ultimate goal of this trend is to make eye care more accessible by deploying numerous low-cost, small machines in various locations. This widespread availability of OCT systems ensures that individuals can undergo basic eye exams, increasing the likelihood of early detection of potential issues. The portability and affordability of modern OCT systems make this technology essential for preventive eye care, allowing earlier detection and treatment of vision-threatening conditions.

Conclusion

As digital screen usage continues to rise, the demand increases for effective eye care solutions for everyone. OCT stands at the forefront of this transformation by offering a non-invasive, precise method for monitoring and diagnosing eye conditions. Advances in mirror technologies and scanning capabilities continuously enhance OCT systems' performance, enabling higher-resolution imaging and faster scanning speeds. The trend toward more affordable and portable OCT machines ensures that eye care remains available to a broader population, facilitating early intervention and better management of ocular health. With these advancements, OCT technology is poised to play an even more significant role in global eye health care in the future.

Contact us at info@hamamatsu.eu or visit www.hamamatsu.com.



Article

When size and performance matters!

Read the article^[2] to uncover the advancements in Spectral-domain Optical Coherence Tomography (SD-OCT) and to explore the transformative potential of **affordable and portable OCT systems**.

References

1. Huang, D., Swanson, E. A., Lin, C. P., et al. (1991). Optical coherence tomography. *Science*, 254(5035), 1178–1181.
2. Izatt, J. A., Choma, M. A., & Dhalla, A. H. (2015). Theory of Optical Coherence Tomography. In W. Drexler & J. G. Fujimoto (Eds.), *Optical Coherence Tomography* (pp. 47–66). Springer.
3. Zara, J. M., Yazdanfar, S., Rao, K. D., Izatt, J. A., & Smith, S. W. (2003). "Electrostatic micromachine scanning mirror for optical coherence tomography." *Optics Letters*, 28(8), 628-630.
4. Wax, A. (2020). "Applications of Low Cost Optical Coherence Tomography." *Biophotonics Congress: Biomedical Optics 2020* (Translational, Microscopy, OCT, OTS, BRAIN), 59(5), OM2E.2.

^[1] Hamamatsu Photonics, Applications, Medical, "OCT (optical coherence tomography)", [online]: <https://www.hamamatsu.com/eu/en/applications/medical-imaging/oct.html>

^[2] Hamamatsu Photonics, "When size and performance matters!" [online]: <https://www.hamamatsu.com/eu/en/news/featured-products-and-technologies/2024/when-size-and-performance-matters.html>