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Press Release
For immediate publication

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Scientists reconfirm suitability of Mirrorcle MEMS mirrors for OCT applications

Recent publications in peer-reviewed journals have re-confirmed that Mirrorcle MEMS mirror devices are an enabling technology for optical coherence tomography (OCT) imaging applications, Mirrorcle Technologies, Inc. (MTI) informs. The California-based manufacturer of gimbal-less MEMS mirrors reports that multiple recent publications by distinguished research groups show that its devices are being used in the latest advancements of biomedical imaging. Previously, the company announced that two commercial customers had adopted the fast two-axis MEMS mirrors for biomedical imaging, namely Wasatch Photonics (USA) and Santec (Japan). At the same time, the enthusiasm in the research community continues and new frontiers in light, hand-held imaging instruments are being explored.

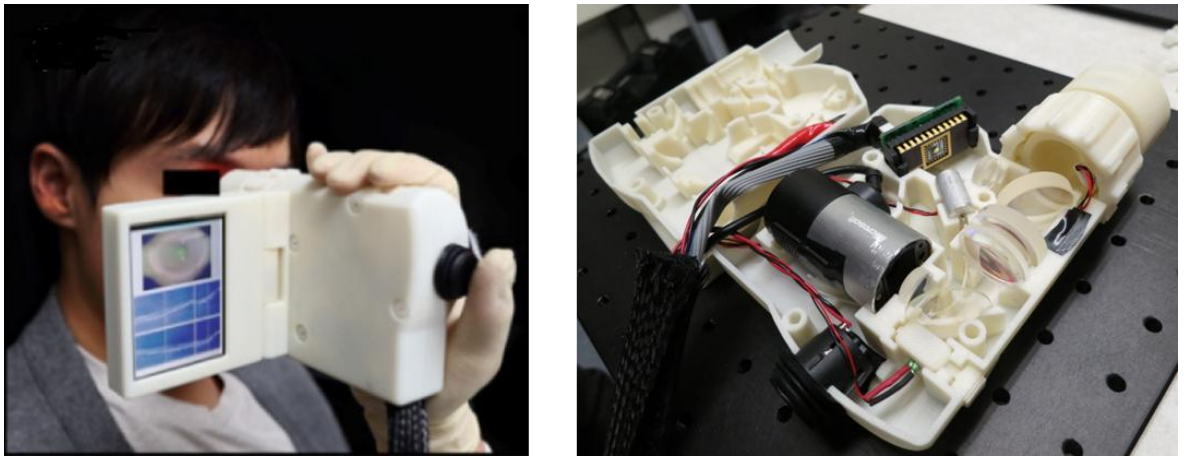

Figure 1. A handheld OCT scanner prototype developed by Lu et al at MIT, utilizing Mirrorcle MEMS mirrors for "ultra-high speed imaging". (left) Photograph of the camcorder style design for acquiring 3D OCT images of the retina, with permission of The Optical Society (Biomedical Optics Express, Volume 5, Issue 1, pg. 293-311). Right image, courtesy of MIT's Chen D. Lu, shows the optics and the gold-coated MEMS mirror of 2.4mm diameter inside the instrument.

Two 2013 publications stress Mirrorcle MEMS' suitability for miniaturized biomedical imaging

There were two notable papers published on biomedical imaging in 2013, both of which utilized Mirrorcle's device to achieve significant technology progresses. The most recent one, by Lu and others at the Massachusetts Institute of Technology (MIT) appeared in the Biomedical Optics Express (Volume 5, Issue 1, pg. 293-311). Researchers report that the capability of ultrahigh speed two-axis optical beam steering by use of the compact, gimbal-less MEMS mirrors made possible the development of a handheld ophthalmic swept source OCT model for retinal 3D imaging. In the second notable publication by Shelton and others (Journal of Biophotonics 1-9; 2013), researchers used MTI's mirrors as replacement for bulky

galvanometer scanners in a handheld OCT probe for e.g. primary care physicians. The authors stressed that Mirrorcle MEMS’s unique and proprietary 4-quadrant actuation approach enabled larger scanning field of view (FOV) and simplified alignment. Furthermore, the user-controlled variable speed of the devices and de-coupled X and Y axes reportedly made possible fully arbitrary scan patterns and scan rates.

Mirrorcle devices have historically been deployed in OCT systems since 2006

In 2006, a group of researchers reported for the first time that MTI mirrors were deployed in an OCT system (Applied Physics Letters, Vol. 88, Issue 16 (2006)). The group utilized the compact actuator design to realize an endoscopic instrument for 3D biomedical imaging. Further advancing the results of this effort, scientists developed a MEMS-based OCT imaging system for real-time, in-vivo and in-vitro 2-D or 3-D Imaging (IEEE/LEOS Optical MEMS and Their Applications Conference, Big Sky, Montana, Aug. 23, 2006). In a related article published in 2008 (Journal of Biomedical Optics, Vol. 14, Issue 3), Mirrorcle MEMS micromirrors helped realize reliable scanning for a fiber-based multiphoton endoscopy application.

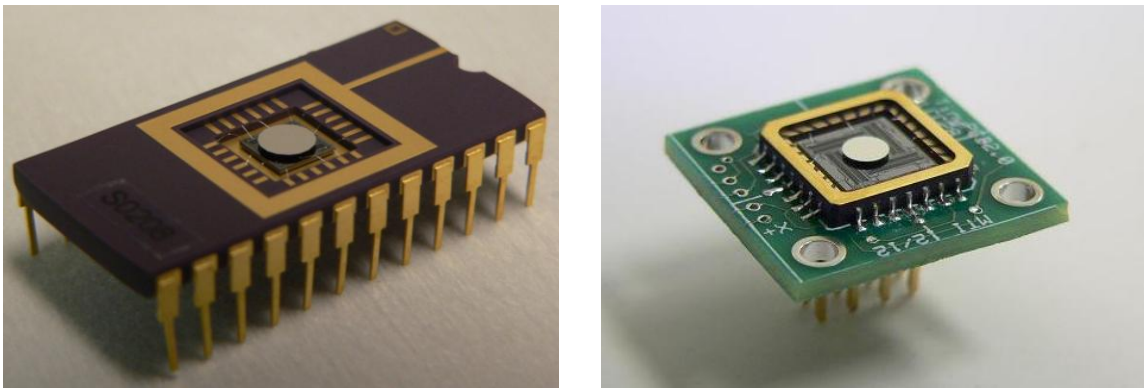

Figure 2. Mirrorcle MEMS mirrors in different packages as used in latest OCT imaging research. A 3.6mm Aluminum-coated mirror (left) as shown in the publication by Shelton et al, *and a 2.4mm Gold-coated mirror in a more compact packaging allowing further miniaturization for such applications.*

MTI MEMS allow for fast optical scans to generate high-resolution 3D OCT volumetric data

In the recent publication by Lu *et al* titled “Handheld ultrahigh speed swept source optical coherence tomography instrument using a MEMS scanning mirror”, researchers took advantage of the small form factor, extremely high repeatability and reliability of Mirrorcle’s MEMS technology, allowing for on-demand 6x6mm or 10x10mm field-of-view volumetric OCT scans. One of the goals of the collaborative development project was to find a suitable substitute for bulky galvanometer servo-motor scanners. These ‘galvos’ inherently come with a number of disadvantages compared to MEMS, namely large form factor, high power consumption, audible noise, excessive heat, and the need to install two of such “galvo”-scanners for raster scanning, one for the X and one for the Y direction. Mirrorcle MEMS devices are capable of highly controllable scans in two axes with just one mirror, and thanks to their gimbal-less, fully symmetrical design they are unrestricted by any ‘fast’ and ‘slow’ axes known from competing technologies.

MIT researchers utilized Mirrorcle’s 13L1 dual-axis MEMS actuator with a 2.4mm bonded mirror and an angular reach of +/- 6° mechanical. Weighing only 2.54g with package and mounting PCB, the 2D scanner is especially suitable for handheld or mobile scanning applications. Another advantage is their low power consumption of <100mW including the MEMS driver HVA. Researchers reportedly took advantage of its high speed capability by conducting two fast volumetric scans, in perpendicular directions, to generate biomedical images. One set of 3D data is obtained by high-speed sinusoidal scan of the X-axis, the second by high-speed sinusoidal scan of the Y-axis. MIT researcher Chen Lu commented: “Because the Mirrorcle Technologies 2-axis scanning mirror had point-to-point scanning capability, wide tilting angles, and small packaging, we were able to replace the larger and heavier galvanometer scanners with the MEMS scanning mirror to produce a much smaller and lighter prototype OCT handheld instrument capable of acquiring 3D volumetric OCT data.” In order to correct for operator and target motion, scientists employed a motion correction software algorithm to merge both scans into a coherent, high-resolution 3D image depicting either 6x6x3.08mm or 10x10x3.08mm volumes. What has traditionally been a large instrument was re-designed and miniaturized into a light-weight OCT model system.

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About Mirrorcle Technologies, Inc.

Mirrorcle Technologies, Inc. (MTI), founded in 2005, is a California corporation that commercially provides products and services based on its proprietary optical microelectromechanical system (MEMS) technology. Since its founding, and supported by its continuous investment in R&D, MTI has offered the world's fastest point-to-point two-axis beam-steering mirrors, as well as resonating-type micromirror devices with rates up to HD video display. MTI is globally the only provider of tip-tilt MEMS actuators in combination with mirrors from 0.8mm to several mm in diameter, offering customers a wide selection of specifications to optimize their paths to successful commercialization. In addition to a variety of existing designs and in-stock products, MTI also contracts to create specialty designs and fabricate custom units and full system solutions.

In addition to the laboratory at its headquarters, MTI has year-round, 24-7 access to wafer-based CMOS and MEMS fabrication facilities. Micromirror fabrication and wafer-level testing are performed in a clean-room environment. Since 2010, MTI has established a manufacturing service cooperation with a leading MEMS wafer foundry, allowing the company to ramp up volume-production while maintaining highest quality standards.

As a privately held company, MTI is able to act efficiently, offering creative and highly responsive service to its customers. The motivated staff is dedicated to provide highest-quality products and support to facilitate customers’ product development and successful commercialization. It draws on several decades of staff’s combined experience in MEMS design, fabrication, and testing.

