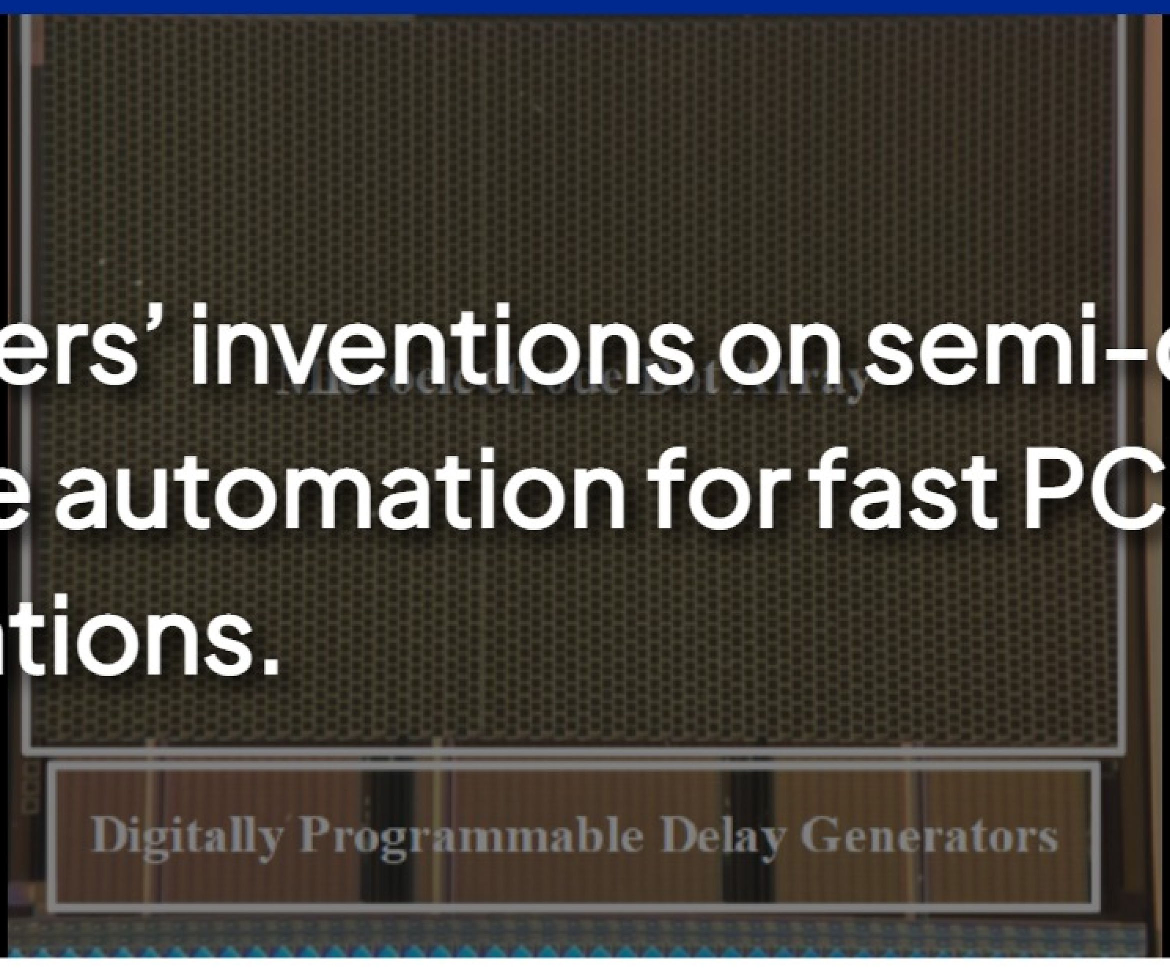
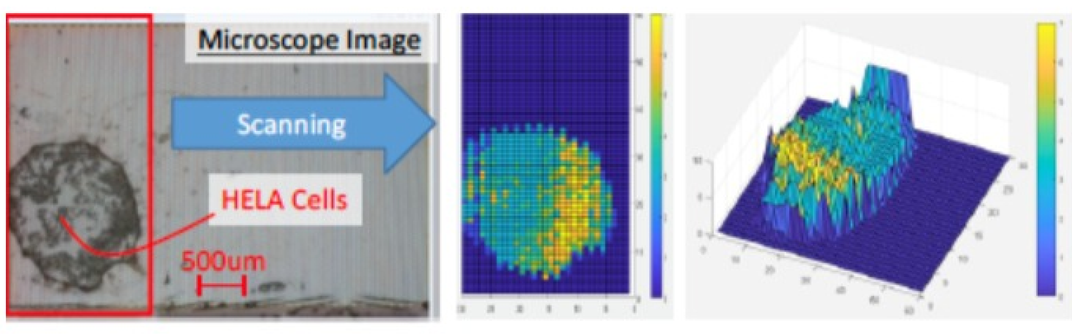
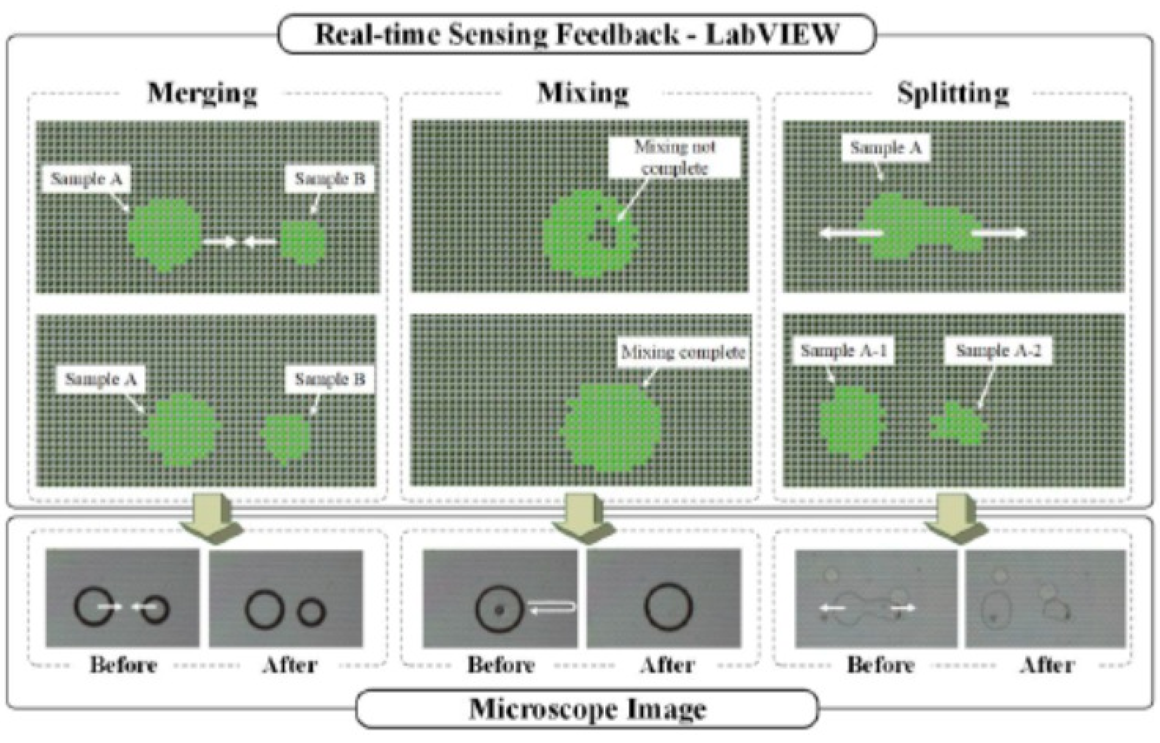


NYCU researchers' inventions on semi-conductor biochips enable automation for fast PCR tests and cell biology applications.

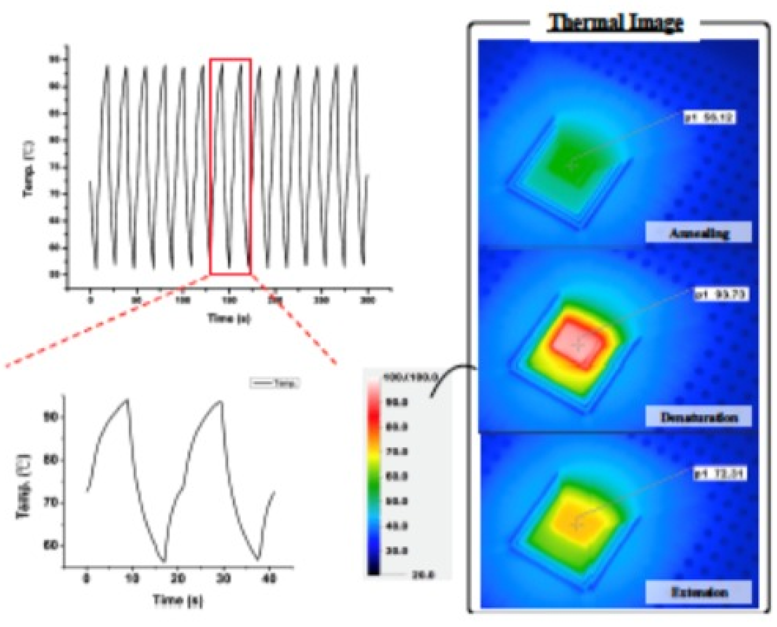


Researchers in the System-on-Chip (SoC) Research Center and Institute of Electronics at NYCU have recently announced a programmable biochip based on standard CMOS process. Different from conventional approaches, this innovative semiconductor biochip provides basic functional modules, such as location sensing, microfluidic operations, temperature control, etc. As a result, bioprotocols for any target sample tests can be derived to achieve automation with less test time and test cost, making this biochip very suitable for emerging applications, such as fast polymerse chain reaction (PCR) tests and cell quality assurance in cell therapy.

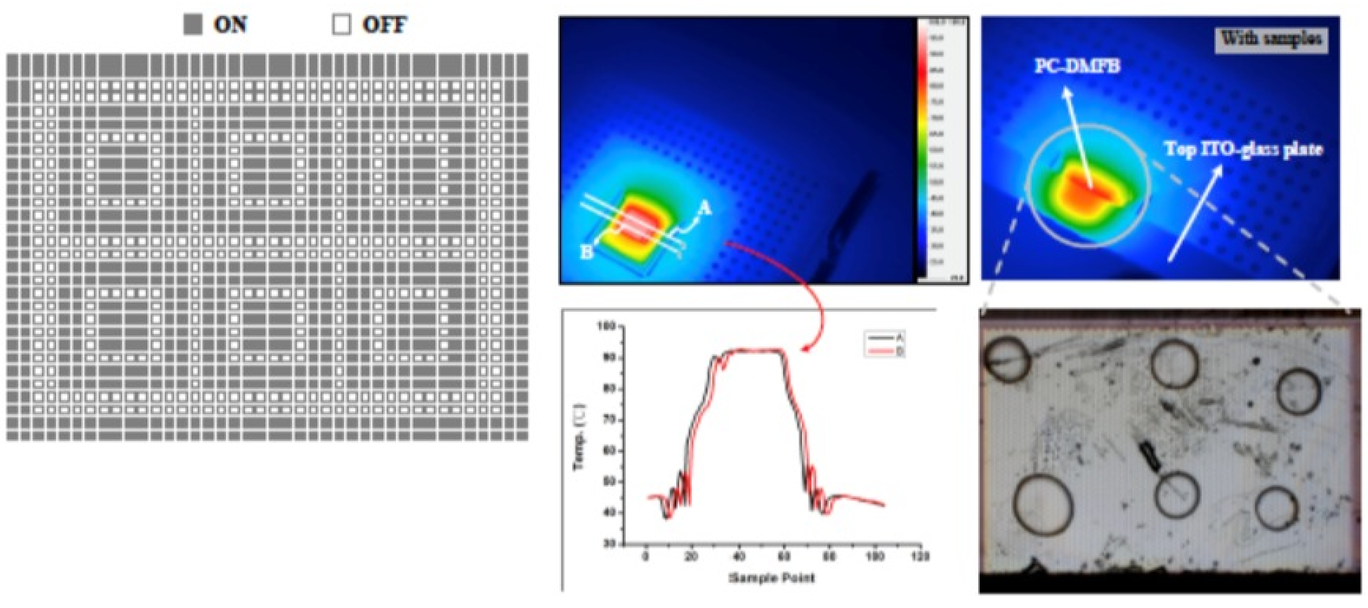
Based on the experience in smart sensing circuit designs, the capacitive sensing mechanism has been exploited in this biochip to identify and locate both sample and reagent are placed on top of the biochip. In addition, permittivity difference from different materials can be easily identified by this biochip by adjusting sampling phase. As a result, this biochip can be used for anti-body and anti-gen tests in a very efficient way. In addition, bit-plane images collected from different sampling phases can be acculumated to form 3D profiling of samples. This technique, named cell tomography, can be applied for cells' quality check to idendify which cell or cell cluster are qualified for further cultivation in cell production. Both spatial resolution and temperal resolution can be further enhanced with the proposed biochip to cover more cell-biology applications.



Microfluidic operations play key important role in bio-experiments using conventional lab-on-a-chip solutions. Researchers at NYCU have also integrated several microfluidic operations (e.g. cutting, mixing, merging, moving, etc) into this biochip based on electrowetting on dieletric (EWOD) mechanism. Thanks to the novel micro-electrode-dot-array (MEDA) architecture, microchannels demanded for different sample tests can be easily programmed on top of the biochip. Combining with the location sensing capability mentioned above, feedback loop control can be applied to monitor the droplet test procedure. Since the biochip can be programmed to meet the requirements of different sample tests, not only bio experiments can be speed up but also contamination failure can be largely reduced. Part of the design automation of this biochip has been in collaboration with Prof. Krishnendu Chakrabarty from Duke University since 2015.

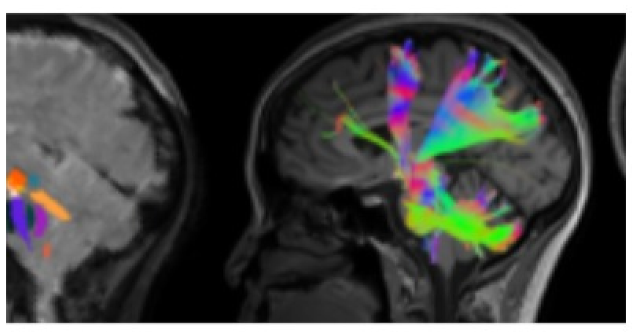


Temperature or thermal cycle control is another important factor for medical tests, especially in PCR applications. Researchers at NYCU have integrated heating sources using digital control patterns to control temperature profile in a very efficient way with the same CMOS process technology. Preliminary measurement results demonstrate that temperature change rate can be higher than 50C/sec. Combining with location sensing and microfluidic operations mentioned above, both single sample and multi-sample can be easily handled on top of the biochip. Note that precise heating regions can be well identified to meet thermal cycle requirement and achieve better energy-efficiency when battery-operated devices are considered.



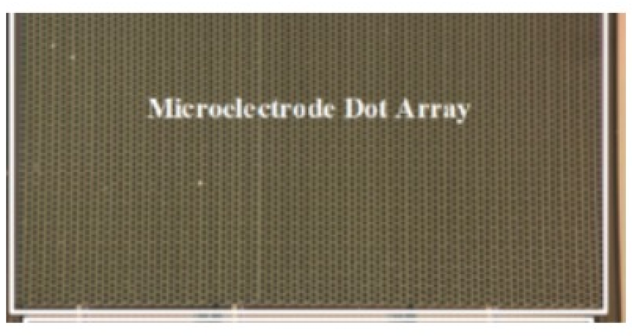
The above mentioned functions can be programmed via 2D digital patterns on the biochip, leading to a possibility of test automation based on bioprotocols derived from target sample test procedures in the very near future. Prof. Chen-Yi Lee, the team leader, highlights that there will be more research opportunities ahead when multi-diciplinary teams are working tightly togeter. Of course, the research outcome will benefit our soceity and pave a way to better life with the current/on-going invention and solutions.
(For more information, please contact the author via cylee@nycu.edu.tw)

More Research Highlights



NYCU brain research facilitates interdisciplinary approaches to uncover the mystery of brain functions

From Bioelectronics to Nano-bioelectronics: NYCU Biomedical Electronics Translational Research Center



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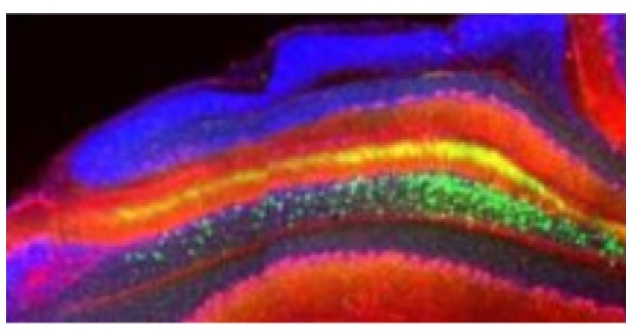

NYCU researchers' inventions uncover genetics and mechanisms underlying brain developmental disorders

Active industry-academia cooperation establishes the NYCU-TSMC Research Center

Yangming Campus
Address: No. 155, Sec. 2, Linong St. Beitou Dist., Taipei City 112304, Taiwan
Phone: +886-2-2826-7000

Chiaotung Campus
Address: No. 1001, Daxue Rd. East Dist., Hsinchu City 300093, Taiwan
Phone: +886-3-5712121

Contact Us