Microelectronics: Automating cancer detection

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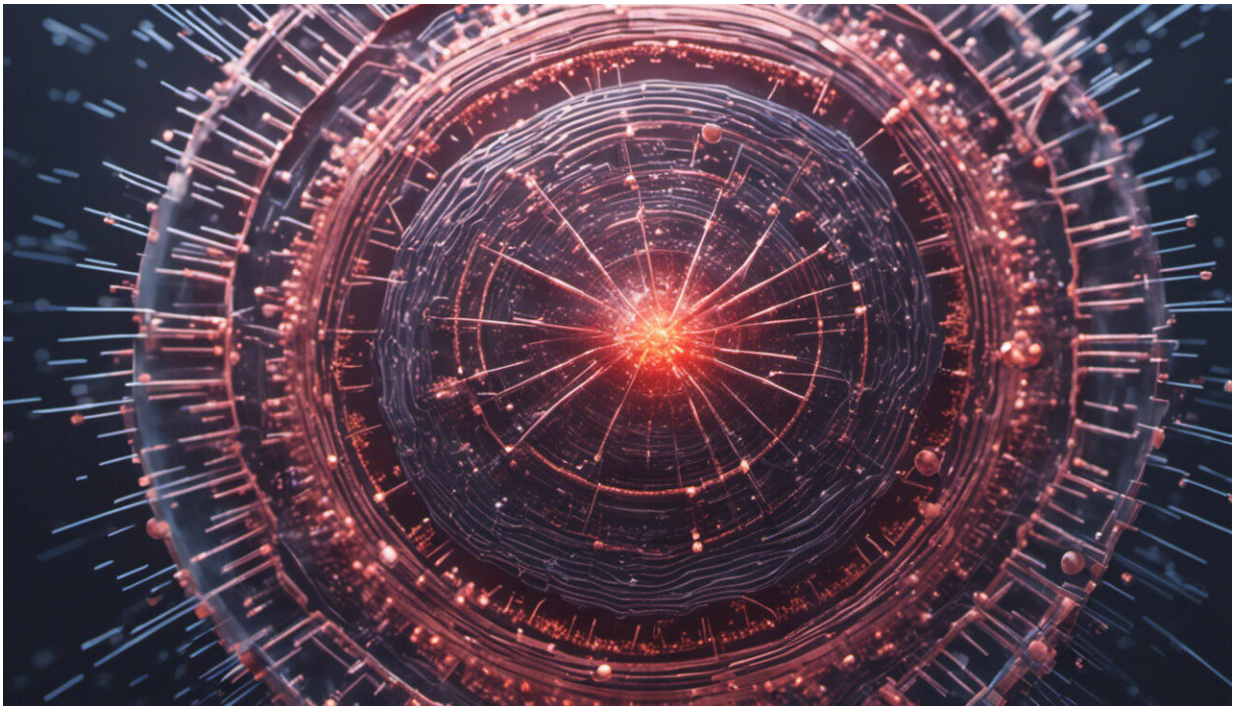

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Microelectronic engineers in Singapore have developed and tested sensor technology that can detect and measure a chemical signature of bladder cancer. The light-based sensor could eventually be used for the early diagnosis and subsequent tracking of the progression and treatment of many different tumors, according to Yong Shin at the A*STAR Institute

of Microelectronics, who led the research. After further testing of the technology, Shin and co-workers are planning to develop a lab-on-a-chip device incorporating the sensor that can process fluid samples within about five minutes.

Genes that suppress tumors can be deactivated by the attachment of a methyl group to a specific DNA sequence—cytosine next to guanine—in their promoter region. The methyl group prevents the gene from being used as a template for protein synthesis and reduces the capacity of the cell to control its own proliferation.

Several well-established chemical methods exist for detecting such DNA methylation, but they are expensive, time-consuming and dependent on laboratory expertise. Shin and co-workers therefore investigated direct physical methods as an alternative. They focused particularly on silicon micro-ring resonators that amplify light at specific resonant frequencies. The resonators developed by the researchers are very sensitive detectors of a shift in light frequency, including the shift that occurs when a methyl group is attached or detached to DNA.

Shin and co-workers tested the capacity of silicon micro-ring resonators to discriminate between methylated and unmethylated forms of genes known to trigger cancer in bladder cells. They fashioned separate DNA probes to capture one or other form when they passed a solution of the genes, amplified by the polymerase chain reaction, over a silicon chip to which the probes were attached. The resonators clearly distinguished between the forms within five minutes. Moreover, the method allowed the team to quantify the density of methylation, which means the technique should be able to track changes in patterns of methylation.

"Our sensors could be widely useful for DNA methylation detection specifically and rapidly in the field," says Shin.

He also notes that the team has published several research papers on using silicon micro-ring resonators. "Among the techniques we have published is a novel technique that can be integrated with the methylation-specific sensor to amplify the methylated DNA from low amounts of DNA," he explains. "So, we are now trying to make a single microfluidic-based chip system that integrates several techniques, such as DNA extraction, conversion, amplification and detection."

More information: Shin, Y., et al. Label-free methylation specific sensor based on silicon microring resonators for detection and quantification of DNA methylation biomarkers in bladder cancer, *Sensors and Actuators B: Chemical* 177, 404–411 (2013). dx.doi.org/10.1016/j.snb.2012.11.058

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