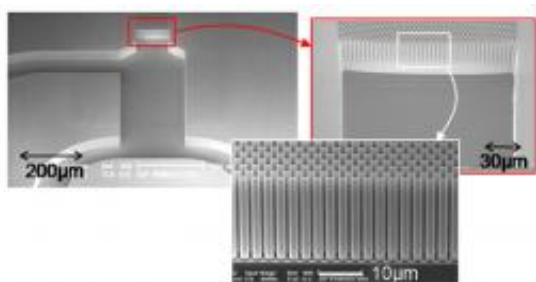


Breakthrough towards lab-on-chip system for fast detection of single nucleotide variations in DNA

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Micropillar array

Panasonic and Imec today present at the International Electron Devices Meeting in San Francisco various critical components of a biomedical lab-on-chip sensor enabling fast detection of Single Nucleotide Polymorphisms (SNPs) in DNA, such as a miniaturized pump for on-chip generation of high pressures, a micropillar filter optimized for DNA separation achieving world-record resolution, and a SNP detector allowing on-chip detection using very small sample volumes.

A SNP is a single nucleotide replacement in a DNA sequence which can result in different reaction by people to [pathogens](#) and medicines. Detection of these SNP's is therefore becoming increasingly important with the move towards more personalized healthcare.

Existing methods to detect SNP's require many sample processing steps in dedicated medical tools at medical laboratories. Such tests are labor intensive, time-consuming and expensive. Moreover, rather large blood samples are needed. A lab-on-chip device can bring huge advantages both to the patient and the healthcare system. Such devices enable fast, easy-to-use, cost-effective test methods which can be performed at regular times in a doctor's office or even near the patient's bed. This is very interesting for point-of-care applications such as personalized medicine.

By combining advanced micro-electronic fabrication processes with heterogeneous integration, imec and Panasonic aim to realize a state-of-the-art microfluidic device for SNP detection. In order to do this, advanced microfluidic components have been fabricated and optimized, such as a miniaturized pump for on-chip generation of high pressure, a micropillar filter optimized for DNA separation achieving world-record resolution, and a SNP detector allowing on-chip detection using very small sample volumes.

The entrance unit of the SNP detection system samples very small volumes of blood. This entrance unit features a miniaturized high-pressure pump based on an advanced conductive polymer actuator. After optimization, the actuator generates high pressures (up to 3MPa) at low voltage ($\sim 1.5V$). The high pressure is essential to generate a fluid flow through the next unit of the SNP detection system. The on-chip low voltage operation is important because it opens the path to autonomy and portability of the lab-on-chip device.

Next, the DNA separation unit featuring an advanced micro-pillar array filter was developed. This deep-UV patterned silicon pillar array was realized using advanced MEMS technology. It consists of many micron-scale pillars, being typically $20\mu m$ high and with $1-2\mu m$ inter-pillar distance. The pillar array is used for DNA separation based on ion-pair

reversed-phase (IR-RP) liquid chromatography. Imec and the VUB (Vrije Universiteit Brussel), a scientific partner of imec, optimized the pillar-based IR-RP liquid chromatography technique for DNA separation. This resulted in the first miniaturized on-chip system that enables fast and highly selective separation of short, double stranded DNA strands which only differ 50 base pairs in length. The resolution of the system is the highest in the world and proves the potential to handle 5 SNPs at the same time in the final SNP detection system.

The other functional units of the SNP detector are a unit for DNA extraction and polymerase chain reaction (PCR) using heaters and temperature sensors, and a SNP detection unit based on electrochemical sensors. The miniaturization of these sensors was of crucial importance, since the minimum required sensor volume determines the blood sampling volume needed for the SNP detection, and hence the dimensions of all components of the device. Scientists of Panasonic and imec demonstrated SNP detection capabilities using on-chip sensors handling a volume as small as 0.5 μ L.

Provided by IMEC

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