



Power to the heart



Multiplexed label-free detection of cardiac biomarkers for point-of-care diagnostics

NanoSniff Technologies is an IIT Bombay based product R&D organisation that works in the sphere of micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems (NEMS) technologies. One of the first Indian companies to offer specialist products around nano scale devices, the company has already commercialised the piezoresistive microcantilever sensor technology successfully. Today, NanoSniff products find applications as sensors for detection of industrial hazards, sensors for security and surveillance applications, point-of-care medical diagnostic devices, education in nanotechnology and MEMS experimentation and applied research in development

of new sensing technologies.

An interesting application has been in the case of acute myocardial infarction (AMI). "About one-third of all the deaths in the world are attributed to cardiac problems. Changing lifestyles have increased the susceptibility to cardiac dysfunctions such as AMI, and India accounts for nearly 60 per cent of the world's heart diseases. Also, the rural public health facilities across the country face problems requiring regular presence of highly trained medical professionals. These factors necessitate the need for an inexpensive, smart, easy-to-operate and rugged sensing system that can be used outside laboratories even by trained primary healthcare nurses," says Dr Nitin S Kale, chief technology officer, NanoSniff Technologies.

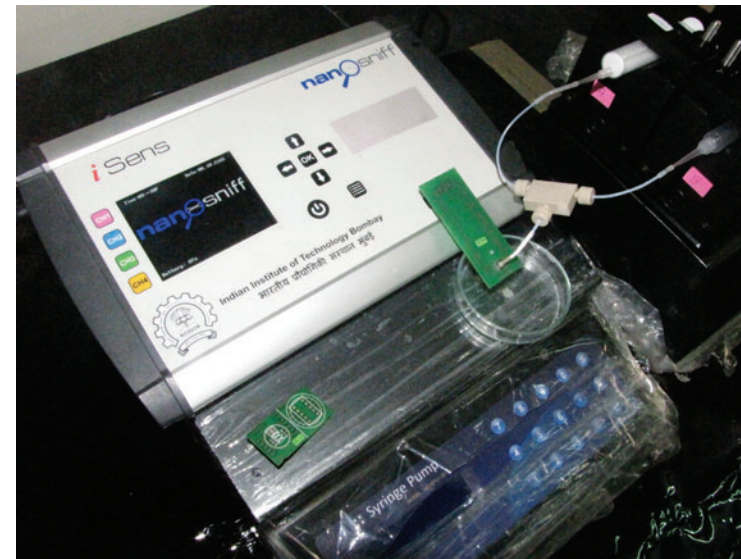
Idea and purpose

Dr Nitin Kale and his team at NanoSniff Technologies have dedicated their efforts over the last one year to address a major contributor to this problem. They aim to develop an instrument to rapidly diagnose myocardial infarction, by detecting cardiac markers released in the blood, using micro cantilevers, micro liquid handling cartridge, and ultra sensitive electronics. "Myocardial infarction has been the scourge of doctors and patients alike because they are difficult to detect early. Due to delayed and uncertain diagnosis, physicians are unable to determine the course of action before the commencement of necrosis, i.e. death of the myocardial tissue," he says.

At the heart of NanoSniff's revolutionary sensing technology is a MEMS structure called micro cantilever. These micro-fabricated cantilevers transduce changes in temperature, mass or surface stress into a nano-mechanical response. This response is represented in the form of an electrical readout by the instrumentation that is built around the cantilever. Antibody immobilisation on the surface of the cantilever, followed by specific antigen binding induces changes in the surface stress of the cantilever due to van



The device can help the patients of AMI



(Top) The device and (above) NanoSniff team working in the lab at IIT-Bombay

der Waal's, electrostatic or steric interactions. The change in surface stress causes bending of the cantilever, which can either be detected optically or through a piezoresistive strain gauge embedded in the cantilever. This piezoresistor responds to the change in strain with about a 100 ppm change in resistance.

Scale and status

Some of the challenges to be overcome are fabricating the piezoresis-

tive micro cantilevers of desired sensitivity, antibody immobilisation on the selected surface of the highly sensitive micro cantilever structure, establishing biological protocols, designing fluid handling system to detect antigens and developing ultra sensitive electronics. Ultimately, the challenge is also about getting all these components integrated.

Also, many patients with AMI do not exhibit classical signs and symptoms. Among many patients with

possible or probable AMI, even ECGs are ambiguous. In such situations it is difficult for a lab to assert the AMI condition. A solution to this problem is to simultaneously detect multiple biomarkers to the AMI condition. The innovation can detect cardiac markers released after the patient suffers a heart attack. "Through the product, we aim to diagnose the smallest AMI at its earliest stage, while avoiding the significant implications of a false positive diagnosis. The number of biomarkers which can be detected can be increased by simply increasing the number of

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cantilevers in an array. Using currently existing microfabrication technologies, arrays of multiple cantilevers can be easily fabricated. Hence multiple biomarkers specific to AMI like troponin, FAPB and myoglobin can be detected simultaneously," explains Dr Kale.

Future

NanoSniff has been successful in getting proof of concept results. The prototype device is able to detect cardiac markers in the lab, under controlled conditions. NanoSniff is currently seeking funds to build another prototype and fluid handling cartridge. Once the design and manufacturing challenges are met, the next step would be to conduct human trials, says Dr Kale.

-Jyoti Verma