PROJECT RESULTS

CT213 | Biosensor platform impacts cost, accuracy and speed of drug detection, heart monitoring and diagnosis in healthcare [3DFF]

With the cost of diagnosis rising in countries with ageing populations, healthcare institutions are understandably seeking ways of deploying new technologies to produce low-cost, fast and accurate diagnostics and analytical systems to keep costs in check. That is why the biosensor platforms – 3DFF project deliverables based on a flexible substrate, and where biosensors combine high performance with low cost – are such a fitting response to these requirements.

Microfluidics is a technology in which tiny amounts of liquids can be used to lower the quantity of reagents and other materials, thus reducing the volume of body fluids used in analytical applications, together with many other benefits. Combined with different types of sensors, this technology can be used to produce small, user-friendly and affordable monitoring and detection devices. However, most of the materials used in marketed products are rigid and the integration of electronics in the chips is often difficult. Developing a broad spectrum of mechanical properties based on a flexible substrate and enabling electronic integration, could lead to interesting security and healthcare applications to assist an ageing population.

Fast, accurate and cost-effective devices for and multiple applications

In a nutshell, the 3DFF project developed a flexible sensor technology to provide accurate, fast, affordable and cost-effective biosensors with a broad range of applications: from security, in vitro medical diagnostics, to in vivo medical diagnostics. This technology is based on a flexible substrate that can integrate seamlessly microfluidic and microelectronics components. It will also form the basis of a disposable sensor which will be complemented with a reader platform able to translate sensor data into information which can subsequently be then presented to the users.

The 3DFF project activities included:

- Market research for defining market opportunities and user requirements;
- Developing microfluidic chips in different materials and with different properties (flexible, semi-flexible and rigid) designed for active and passive fluidic handling;
- Developing biocompatible flexible interphases for skin adherence in wearable devices;
- Developing novel electrochemical biosensors and a piezo-electric sensor;.
- Integrating sensors in flexible structures;
- Developing electro-chemicals;
- Developing three platforms corresponding to use-cases;
- Validating the platforms through animal models or by using biological samples.

Key project deliverables were three application platforms:

1. Drug-of-abuse (DOA) detector: A quantitative rapid illicit-drug-detection device for roadside police controls which is the first of its kind (there are only qualitative detectors currently). It includes microfluidic disposable cartridges (for avoiding cross- contamination) and an electronic reader;

2. Cardiac body-patch: A flexible patch with a novel piezo-sensor which led to a miniaturised cost-effective patch for cardiac monitoring. The device is capable of wireless communication with a PC for data acquisition in real-time;

3. Flexible skin-patch with chemical sensor: A microfluidic chip containing a qualitative rapid test stripe for detecting alarming-levels of morphine in sweat, for palliative-care patients.

Supporting European industries and development

Co-operation among project partners with just the right attitude was key to successfully dealing with technical problems and management issues. In general, the project benefited from good interactivity between small and large companies. A good example is the piezo-sensor, where good synergy between two project partners made its microfabrication possible. Technology transfer also helped the project, especially public research centres and small- and medium-sized enterprises (SMEs), where a good balance between new, advanced technologies, and market pragmatism was attained..

PROJECT CONTRIBUTES TO

- Communication
- Automotive and transport
- Health and aging society
- Safety and security
- Digital lifestyle
- Design technology
- Sensors and actuators
- More than Moore
- More Moore

PARTNERS

Toppan Photomasks (TPI)
Alphasip (ASIP)
BodyCAP
Hemosoft
Boschman (BT)
Advanced Packaging Center (APC)
Laboratoire de Photonique et de Nanostructures – (LPN)

COUNTRIES INVOLVED

- Spain
- France
- Turkey
- The Netherlands

PROJECT LEADER

David Olea Duplan
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KEY PROJECT DATES

December 10, 2012 - November 30, 2016

There are also spinoffs that could benefit the semiconductor, healthcare and allied industries in Europe (and beyond). By mixing polymers with micro-electronics, the project reinforces the research policy of the European Union (EU) concerning electronics fabrication in Europe. This creates new applications, instead of just competing for the smaller chip technology. Biomedicine and other sectors can also benefit from these new developments.

3DFF also supports the development of a European system-in-package (SIP) supply-chain for innovative systems and differentiating technologies through 3D (three dimension) and heterogeneous integration. The development of a 3D integrated microfluidic technology – a 3DFF objective – will ensure features, like multiplexing, flexible reception systems, miniaturisation and heterogeneous integration, are included in the development of SIPs, thus ensuring different application areas also benefit.

Likewise, innovative technology addressed in 3DFF, could clearly promote European leadership in the supply chain for 3D/SIP by exploiting existing strong interaction between technology development and application domains. For example, this project applies developed technology in two application domains: roadside drug-screening; and healthcare in vitro diagnostics, where a point-of-care (POC) device is used to help rule out, among other conditions, deep vein thrombosis (DVT).

And by ensuring competiveness in three European healthcare sub-sectors – security, in vitro diagnostics and health monitoring – 3DFF seamlessly ramps up the concept from prototype (feasibility) through various designs in a single, flow-to-mass fabrication. It also creates a large application field to produce chips with the reliability, speed, pitch and pin count necessary for optimal performance, including lower-power usage, and a faster time-to-market.

Vibrant markets

The expected impact of this project is significant because of the high market-volume on which 3DFF is focused. Firstly, an accurate and cost-effective POC test for cardiovascular disease (CVD), for instance, will increase survival after a thromboembolism (a combination of thrombosis and embolism) and also effectively reduce costs. POC use of CVD is gaining in popularity, with an estimated market of US$ 830m in 2008. This means targeting EU (27%) and North-American (45%) markets – where an unhealthy stressful and sedentary way of life is prevalent – makes good commercial sense.

Then there is drug-testing. With European authorities strongly promoting road safety through strict policies against driving under the influence of drugs, such a reliable, low-cost, portable drug-screening device would be ideally placed to significantly decrease the number of road accidents. There are also broader potential markets for this product. Global estimates suggest that the economic costs of road traffic injuries amount to US$518 billion annually. In developing countries, the costs are estimated at US$100 billion, twice the annual amount of development aid to developing countries.

And that is not all. 3DFF introduces a synergy that could lead to the creation of new R&D projects involving consortium participants. Furthermore, knowledge acquired in this project will drive technological transfer applicable in other areas. 3DFF will also promote the different R&D areas of this project and foster new research lines. This could directly affect job creation linked to production and sales of demonstrators developed in 3DFF. In the long term, this technology could even increase European employment, creating more than 200 jobs for manufacturing these devices, and 100 jobs in research, administration, finance and sales.

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CATRENE (E! 4140), the EUREKA Cluster for Application and Technology Research in Europe on NanoElectronics, will bring about technological leadership for a competitive European information and communications technology industry.

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