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Analytical Microsystems for Biomedical and Environmental Applications

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Two types of analytical microsystems for the detection of species of interest in biomedical diagnosis and in environmental monitoring are specifically described in this paper.
We describe a novel device that will measure whole blood concentration of D-dimer, a recognized biomarker of increased blood clotting activity and that will then offer opportunity to use the test in the point of care setting. The device combines innovation in antibody bio-engineering for high specificity immunoassay-based diagnostics and nano/micro engineered impedimetric analysis electrodes incorporating a biocompatible polymer substrate with development of a disposable microfluidic manifold, enabling diagnostics at the point-of-first-contact.
The feasibility of a generic microsytem integrating a microfluidic system of concentration and a module of electrochemical detection is demonstrated for the four metals of the European directive (DCE 2000/60/EC) for the quality of water resource: cadmium, mercury, lead and nickel.

K e y w o r d s: analytical microsystems, fluidic microsystems, Electrochemical Impedance Spectroscopy, Deep Venous Thrombosis, water resource, heavy metals, diamond like carbon

1. Introduction

Analytical microsystems allow to integrate the different functions necessary for the detection of species of interest in a biomedical or an environmental sample: uptake of the sample, temperature control, filtration, mixture, preconcentration, separation, labeling, quantification… on a single chip.Two types of analytical microsystems for the detection of species of interest in biomedical diagnosis and in environmental monitoring are specifically described in this paper.

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Diagnosis and hence treatment of disease is often reliant on an interpretation of chemical parameters within biological samples. Currently many of these measurements are performed in centralized laboratories, requiring specialized equipment and expert personnel. This approach, whilst delivering high quality results, can delay diagnosis and hence delay commencement of treatment. There is an emerging requirement for diagnosis to be made at point of first contact with the patient, requiring clinical measurements being made outside the laboratory using compact, portable devices that can be operated by non-specialised people. This approach, known as point-of-care testing, is particularly applicable when there is a need for rapid diagnosis and fast initiation of treatment.

Monitoring of water resources and natural environments is a major environmental challenge for the coming years involving numerous actors (local governments, water agencies, regulators, managers of water treatment, citizens). In particular the Framework Directive on Water WFD 2000/60/EC, applicable in France and Europe, requires knowledge and monitoring of a large number of substances called priority with the objective, the return to good status of water bodies before 2015. In this context it is essential to develop tools to monitor in real time the condition of water bodies.

A chemistry of the environment to learn about the quality and operation of water systems must adapt to their dynamic and geomorphological features. To do this we must develop methods of investigation with the following qualities: economic resources to be able to increase the number of measurements; self to limit maintenance costs, fast to follow transient events, reliable and accurate in order to keep the quality of current measurements and finally non-disruptive not to modify the concentrations around the point of measurement.

If the analysis in laboratory provides deployment of a wide range of analytical techniques allowing accurate detection of the specific analytes, it does not meet these requirements. Development of the micro-analytical systems suitable for continuous measurements, opens up an innovative mean for quantification of pollutant flows in the environment and their monitoring in real time.

2. Medical Diagnosis Device for Deep Vein Thrombosis

Venous thromboembolism represents a single disease entity with two patterns of clinical presentation: deep vein thrombosis and pulmonary embolism. The deep vein thrombosis (DVT) is an internal clot formed in one of the body's deep veins, usually one of those in a leg. If a part of the clot breaks free and moves into the lung, it can lead to the pulmonary embolism (PE), an often a fatal condition. The venous thromboembolism afflicts an estimated 71 per 100,000 persons yearly, and DVT and PE are major causes of unexpected mortality in hospitals throughout the Europe [1–4]. It is essential to make the diagnosis quickly and accurately and to start the treatment promptly.