SHAPE ANALYSIS DEVICE

FIELD OF THE INVENTION

The present invention relates to a device for the characterisation of one or more particles in a fluid sample.

BACKGROUND TO THE INVENTION

The discovery and deployment of new materials requires their detailed characterisation. In the case of emerging materials for environmental (energy, agricultural), healthcare (nanomedicines, therapeutics) or food industry (food, packaging) details such as size, shape, charge, and concentration are essential. There is increasing evidence that properties of materials such as nanomaterials and their applications are not only dependent on the chemical properties of the materials but also the physical and mechanical characteristics of the materials. Rapid, onsite or inline analysis within the manufacturing industry is limited. Current state of the art uses microscopy (electron or optical) which is costly, low throughput and provides limited information of the materials in their natural environment. Solution based techniques include light scattering which can be complicated by flow. Furthermore, it can be difficult to work with multimodal sample sets and turbid solutions. There is also lack of technologies available to quantify shape properties of nano-objects in a high-throughput manner.

An emerging technology over the last two decades, which has become more common place for biological samples such as DNA, are Resistive Pulse Sensors (RPS). Most of the research and commercial activity within RPS has focused on DNA sequencing/analysis. The theory and applications of RPS for nanomaterials is emerging and growing rapidly and is ready to be exploited and applied to the manufacturing of emerging nanomaterials.

The traditional route for analysis of materials is to run the reaction/synthesis, extract and then analyse the products. These workflows are often referred to as batch reactors. The translation of batch synthesis onto continuous flow platforms represent an area of increased research over the last decade. They offer lower production costs, as well as reducing the variation in products from batch-to-batch. However, infrequent sampling/monitoring of the reaction within fluidic reactors limits the benefit of the flow process. Thus, improvements within micro-reactor systems lie in the manufacturing of complete laboratories on a chip. These “lab-on-a-chip” devices guarantee uniform mixing, and fluidic behaviour with integrated continuous inline monitoring of chemical products for high-throughput processing.

It is desirable for a sample mixture to have individual particle sorting and analysis so that the size, charge and concentration of various particles can be determined. Current techniques have a fixed range such that they only measure one type of material. There is a need for high-throughput inline sensors for nanomaterials with single particle resolution, capable of dealing with nano to micro particles.

An emerging fabrication process for microfluidic systems is additive manufacturing (AM) or 3D printing. It is a favourable alternative mainly due to its ability to build a 3D design from an STL (standard tessellation language) file with no intermediate steps, thus minimising labour, time and costs. AM allows bespoke flow channels to be designed and interfaced into for the analytical platform.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided a device for characterisation of one or more particles in a fluid sample, the device comprising: an inlet; an outlet; a microfluidic channel extending between the inlet and the outlet and providing an axial flow path for fluid flowing therealong; a particle sensor for detecting the passage of particles moving along the axial flow path first and second electrodes positioned along the microfluidic channel; and wherein, in use, one or more particles flowing along the microfluidic channel are detected by the first particle sensor and passage of said one or more particles is recorded as a pulse (e.g. a resistive pulse).

According to a second aspect of the present invention, there is provided a device for characterisation of one or more particles in a fluid sample, the device comprising: a first particle sensor comprising a base comprising a microfluidic channel, wherein the microfluidic channel comprises a first electrode and a second electrode positioned along the microfluidic channel, and a detection region between the first and second electrodes; an inlet; and an outlet, wherein in use, a fluid sample comprising at least one particle flows in through the inlet, along the microfluidic channel of the first particle sensor, over the first and second electrodes, and exits through the fluid outlet, and wherein the passage of said at least one particle through the detection region is recorded as a pulse (e.g. a resistive pulse).

According to a third aspect of the present invention, there is provided a computer implemented method, comprising: receiving, as an input from a particle sensor having first and second electrodes, pulse data representing a current pulse corresponding to a particle, and comparing the received data to prestored characterising shape data representing particles of known shape; determining, based on the comparison, a shape of the at least one particle; and outputting an indication of the determined shape of the particle.

According to a fourth aspect of the present invention, there is provided a computer implemented method, comprising: receiving, as an input from a particle sensor having first and second electrodes, pulse data representing a current pulse corresponding to a particle of known shape; and determining a model in dependence on the received data indicative of the particle of known shape.

According to a fifth aspect of the present invention, there is provided a computer-implemented method of characterising a nanoparticle, comprising: receiving pulse data indicative of current flow between first and second electrodes associated with a microfluidic channel whilst the nanoparticle passes though the microfluidic channel; classifying the pulse data as corresponding to one of a plurality of predetermined types of nanoparticle using a pulse-shape model.

FIGURES

The present invention will now be described by way of example only and with reference to the accompanying drawings in which: