Paper Based Microfluidic Devices for Environmental Diagnostics

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Microfluidics has found widespread application in the fields of molecular biology, DNA analysis and most recently, point of care diagnostics. The onset of paper based microfluidics in particular, has catapulted research within the low cost diagnostics field. Paper based microfluidic assays have been developed for the sensitive detection of glucose and protein in blood and urine (1). The aim of these developments was to increase accessibility to basic health care within developing nations. Recently, the potential paper based microfluidics has to offer the environmental monitoring sector, such as air and water pollution monitoring, has been realised. These devices are well suited for in-the-field testing as they are made from light-weight fibrous materials that are easily transported to remote locations, are disposed of by simple incineration and have a low reagent and sample consumption. These devices are able to withstand the harsh conditions prevalent during at-the-source detection such as elevated temperatures and mechanical stresses.

Paper based microfluidic chips are patterned with micron sized hydrophobic barriers which penetrate the paper's cross section. These barriers guide the capillary movement of fluids through the cellulose fibres. A sample enters at the device inlet and travels towards a detection region. In between these two points, sample pre-treatment and signal amplification steps may occur. Detection regions, preloaded with analysis reagents, then provide either a visual or electrochemical signal, indicating whether the analyte is present in the sample. Although based on a similar operational principal as lateral flow technologies (such as home pregnancy tests), paper based microfluidics seeks to offer a more "intelligent" solution, by incorporating a series of processes onto a single device and enhancing result quantitation.

We present a paper based microfluidic device for rapid, in-the-field detection of pathogenic bacteria in water. Conventional detection methods require a 24 hour culturing step, making them incapable of providing real time results. This means communities are allowed to continue using contaminated water until a result is obtained and a warning is issued. By then, it may be too late to prevent illness. The device makes use of the natural recognition properties of antibodies for antigens and uses nano-gold particles to create a visual test result. The device is designed using design programmes and manufactured using solid ink printing technology. Initial targeted users include municipal field workers and waste water treatment plants.

References

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