A microfluidic magnetic fluidized bed as point-of-care platform: its application to bacterial detection

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Fluidization is a steady-state dynamic regime in which solid particles show a fluid-like behavior under two directionally opposite but equal forces. Fluidized beds are commonly used to enhance surface interactions in a solid/liquid mixture, with high stirring and low backpressure. Our team developed a completely new concept of micro-fluidized beds (μFB) based on magnetic micro-particles in equilibrium between flow-induced drag forces and magnetic forces [1]. This system already showed unprecedented efficiency for solid phase extraction and was successfully applied for the detection of bacteria [2] and implementation of a competitive immuno-assay [3].

I will describe how we leverage the unique properties of the μFB to enable the rapid detection of bacteria in liquid samples through a two-step microfluidic assay. First, an immune-extraction and pre-concentration step of Salmonella typhimurium is performed with evaluated capture rates of 90%. Immediately thereafter the captured bacteria are cultured in situ with a constant flow of nutritionally rich medium. Their growth results in an expansion of the fluidized bed enabling the direct detection of salmonella by visual monitoring. Moreover, the expansion times directly depend on the sample concentration, allowing precise quantifications of the initial bacteria coupled with a very high sensitivity.

Finally, our latest developments are aimed at improving the processing capabilities of the μFB to tackle some of the most demanding challenges of biomedical trace analysis and allow the direct blood treatment of patients, both requiring the processing of 100s μL to mL-size sample volumes [4]. I will present then a new generation of μFB that allows 0.5-1.2mL/h flow-rates with no significant loss of extraction performance.

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