Separation and identification of a mixed sample using a cDEP-Raman device

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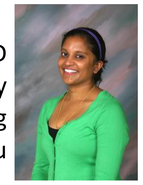


Typical bacterial identification methods can take several days to complete. In order to reduce analysis time, researchers have used a variety of methods for bacterial identification such as polymerase chain reaction, Raman spectroscopy, and fluorescent in situ hybridization. Although these methods have successfully decreased bacterial analysis time from days to a matter of hours, they require a pure sample or a way to label bacteria with fluorescent tags, antibiotics, or primers. Pure samples require a number of purification steps that lead to loss of sample, and appropriate fluorescently-marked antibodies increase costs and wasted materials due to the broad range of bacteria strains that cause infections and disease. As such, label-free isolation and identification methods like dielectrophoresis (DEP) and Raman spectroscopy are appealing to reduce costs and increase simplicity and efficiency. DEP is the motion caused in a particle as it passes through non-uniform electric field and can be used to sort, isolate, and trap particles. This study successfully demonstrates a single platform for simultaneous trapping and identification of *Mycobacterium* sp. MCS away from 5 μm polystyrene spheres using DEP and Raman spectroscopy.

Introduction

Dielectrophoresis (DEP) is becoming a more popular means for sorting of biological samples as it is a label-free technique. The technique requires a non-uniform electric field, which causes motion in neutral particles as illustrated in Figure 1.

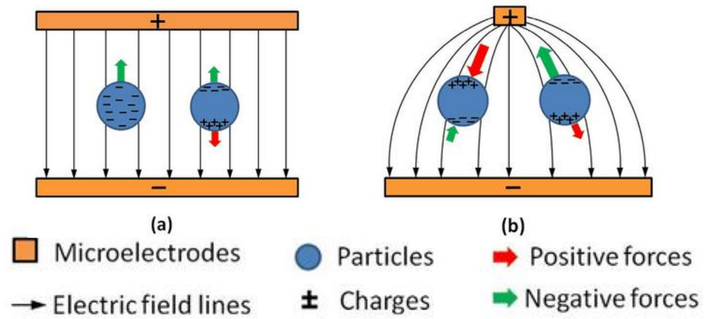


Figure 1: Schematic showing the difference between electrophoresis (a) and dielectrophoresis (b). Image taken from [1].

DEP can be used to isolate bacteria in order for another technique such as Raman spectroscopy to identify bacteria. Figure 2 illustrates the process of Raman scattering, resulting in spectra that can be used as a means to identify samples.

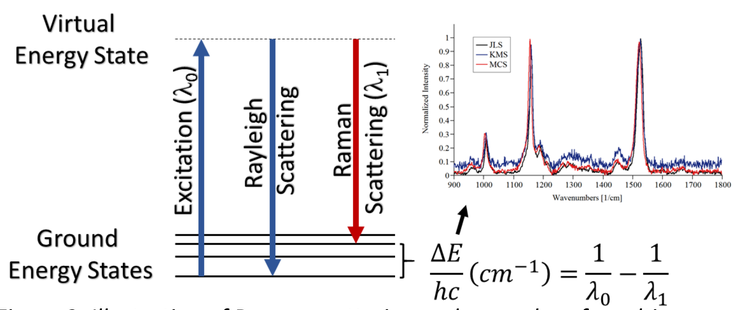
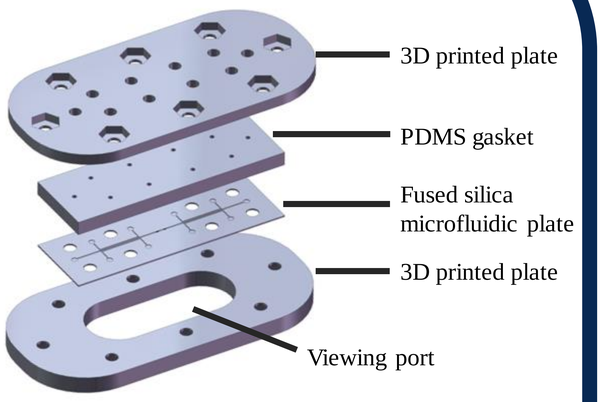


Figure 2: Illustration of Raman scattering and examples of resulting spectra.

This study successfully trapped and identified bacteria from a mixed sample by means of DEP and Raman spectroscopy indicating the potential of the device to decrease the analysis time of bacteria from clinical samples.

Design

Figure 3: Representation of a DEP device composed of fused silica, PDMS, and 3D printed materials. Layers are held together with 8-32 screws and bolts [2].



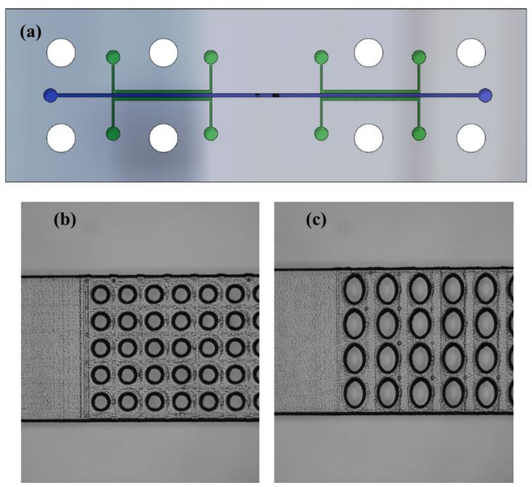


Figure 4:Schematic of fused silica microfluidic plate (a) with green and blue channels, indicating the liquid electrode and sample channels, respectively. Brightfield images of first (b) and second (c) pillar arrays positioned in the middle of the sample channel. In (b), pillars are 60 mm diameter while in (c), the length of and width of the hoval pillars are 100 and 60 mm respectively .

Results

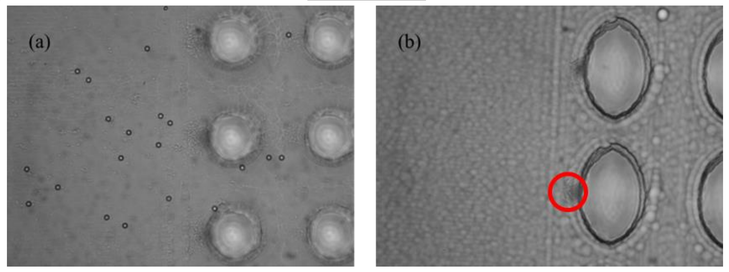


Figure 5: Brightfield images of isolating bacteria away from 5 μm polystyrene spheres acting as debris. Image (a) is of the first pillar array to trap debris. Image (b) is of the second pillar array to trap bacteria. The red circle indicates the area where bacteria is trapped and Raman spectra were collected.

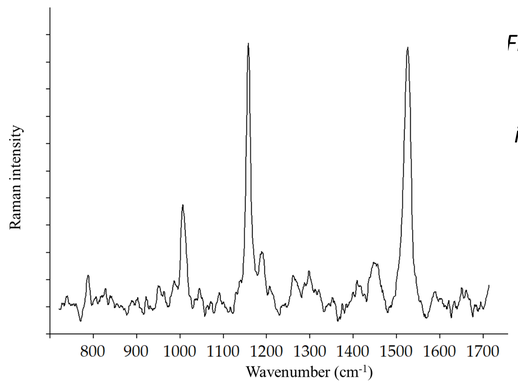


Figure 6: Image of Raman spectra collected from Mycobacterium sp. MCS isolated away from 5 μm polystyrene particles. Spectra were collected using 785 nm laser, 60 second acquisition, and one accumulation.

Discussion

This study successfully demonstrated the simultaneous isolation and identification of *Mycobacterium* sp. MCS from 5 μm polystyrene spheres in a DEP-Raman device, proving the capability of isolating bacteria from a mixed sample on a single platform. The device shows clear potential for decreasing the analysis time of bacteria for clinical samples.

References

[1] M. Li, et al., *J. Phys. -Appl. Phys.*, vol. 47, no. 6, p. 63001, Feb. 2014.

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