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Dielectrophoresis for Raman analysis in liquid: applications to bacteria and viruses

Raman microspectroscopy has recently been employed for the characterization of an increasing number of biological and environmental specimens. The speed and non-destructivity of the technique and its compatibility with water matrices can be exploited for live measurements on time-sensitive reactions, degradation, structural changes, drug uptake, vitality, and more. Dielectrophoresis (DEP) is the motion of dielectric particles by non-uniform electric fields [1]. DEP was employed to manipulate biological suspensions to locally concentrate the analytes to maximize Raman signal using a specially built cell. The design of this device was optimized by measuring polymer beads of various sub-micrometer sizes; Raman-DEP was then applied to live bacteria and active viruses in biologically compatible mediums.
The characterization of different bacterial strains, namely *E. coli*, *S. aureus* and *P. aeruginosa*, was carried out; DEP-aided Raman was then applied on *E. coli* treated with the commonly prescribed antibiotic ciprofloxacin (1 µg/ml, the minimum inhibitory concentration in the conditions of the experiment) proved that spectral changes in the bacterial chemical fingerprint due to the mode of action of the antibiotic were detectable after only one hour of treatment (traditional methods require 24 hours or more). Furthermore, with multivariate spectral analysis it was possible to create a test to determine antibiotic resistance and biocide-induced cross-tolerance of bacteria, that was validated by standard microbiological assays methods [2].
Moreover, DEP allowed the acquisition of conventional Raman spectra on different purified active viruses in liquid, and without the use of plasmonic enhancing surfaces or particles; a Raman spectral library of viruses was achieved. This method could allow the live study of the responses of isolated and inoculated viruses to conditions and chemicals, paving the way to the employment of Raman to new frontiers.

References

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Figures

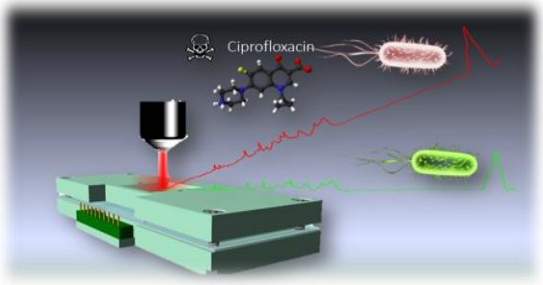

Figure 1: DEP device applied to Raman analysis a bacterial suspension.