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Raman microscopy meets microfluidics: an integrated approach for rapid diagnosis and cell sorting

Individual phenotypic differences exist ubiquitously in biology. The importance of identifying and isolating key individuals from populations has become increasingly recognized in many fields. While fluorescence-based technologies dominate current methods, the desire not to interfere with the "natural" cell state and/or the lack of known biomarkers makes label-free sorting strategies extremely attractive. In particular, for naturally occurring microorganisms, most of them are not cultivable in the lab, and our knowledge of their specific biomarkers is limited. Single cell Raman spectra provide an intrinsic chemical 'fingerprint' of individual cells, which can characterize cell types and metabolic activities. By integrating microfluidics with Raman spectroscopy, we have developed several platforms to study cell populations at the single-cell level. Our approaches enable quantitative and real-time analysis of individual cells without the need for external labelling processes. With this capability, we have recently realized rapid diagnosis of pathogens from sample to results within minutes. We have also developed a series of flow-based Raman-activated cell sorting (RACS) platforms using single cell Raman spectra as a readout for cell identification. Our platforms enable automated, high-throughput isolation of individual cells with desirable traits in a community for downstream culture or genetic analysis. They can be applied to a wide range of samples (from 1 μm bacteria to mammalian cells) and provide a versatile tool for function-based flow cytometry and sorting applications in the fields of microbiology, synthetic biology, life science, and diagnostics..

References

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