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My main research interest is to develop tools to investigate nanoscale phenomena. I have developed a dedicated scanning probe microscope to measure sub-picoNewton forces parallel to a flat surface. The name of this technique is the lateral molecular force microscope (LMFM). The sensors used in a LMFM can have stiffness a thousand times smaller than the ones used in conventional atomic force microscopy and measure femto-Newton forces. The first application of LMFM has been the measurement of weak optical forces generated by evanescent fields. We also used these extra compliant micro-cantilevers to observe the processivity of biomolecular motor proteins.
We recently developed an evanescent field sensor to detect intracellular fluctuations within bacterial cells (SCFI). We discovered that these fluctuations can be related very precisely to the metabolic state of the bacteria when exposed to antibiotics. Using this technique, we have developed a protocol to perform rapid antimicrobial susceptibility tests that could become a tool against the spread of antimicrobial resistance.

"Developing a rapid label-free antibiotic susceptibility test"

Determining the viability of bacteria in a sample is an essential microbiological technique used in healthcare, industrial bioprocesses and research. For some applications, it is critical to obtain a rapid assessment of viability. Due to the rise in antibiotics resistance, the attention has been focussing on new antibiotics susceptibility tests (AST) to allow quicker and appropriate prescribing of antibiotics. Current AST methods are limited in speed as they rely on detecting the growth of microorganisms in the presence of antibiotics as a measure of viability and hence antibiotic susceptibility. Here, we present a rapid phenotypic viability test using Sub-Cellular Fluctuations Imaging (SCFI). This new imaging technique, based on an evanescent wave sensor, reveals the nanoscale fluctuations that living cells exhibit within their cell envelope. In particular, we show that SCFI can quickly measure the viability of bacteria, clearly distinguishing not only between live and dead bacteria but also live bacteria in different metabolic states. Importantly, we subsequently show that SCFI can identify antibiotic-treated resistant and susceptible bacteria within 30 minutes, providing a comprehensive diagnostics tool ideally suited for rapid AST.