Open-Access Optical Microcavities for Lab-on-a-Chip Spectroscopy

Dean James [1], Aurélien Trichet [2], James Foster [1], Naomi Omori [2], Jason Smith [2] and Claire Vallance [1]
[1] *Department of Chemistry, University of Oxford, UK*
[2] *Department of Materials, University of Oxford, UK*

Open-access optical microcavities provide a novel approach to performing label-free on-chip spectroscopic measurements in a microfluidic environment. Arrays of concave micromirrors are fabricated by focused ion beam milling of a suitable substrate followed by deposition of a suitable dielectric mirror coating. Arrays of microcavities are constructed by positioning a micromirror array a few microns from a planar dielectric mirror. The resulting cavities have mode volumes of tens of femtolitres, with cavity finesse on the order of 10^3 to 10^4. The small cavity lengths result in a large free spectral range, such that only one or a few wavelengths are resonant inside the cavity within the reflection bandwidth of the mirrors. This property is key to the use of the cavities in chemical sensing applications. The mirror separation can be controlled with sub-nanometre precision using piezoelectric actuators, providing a simple mechanism for tuning the cavity resonances to any desired wavelength. For initial proof-of-concept work, the microcavity arrays have been incorporated into a flow cell, allowing liquid samples to be flowed into and out of the cavities. To date, we have demonstrated both refractive index and absorption sensing down to the level of a few thousand molecules, as well as the ability to track the motion of individual nanoparticles within the cavities through their interaction with the various longitudinal and transverse cavity modes. Recent results from these studies will be presented.