Abstract

Fluorescence based real-time monitoring of different organic and biological entities has tremendous potential towards development of commercial sensing platforms and point-of-care devices. However, the major drawbacks of conventional fluorescence technique are its low collection efficiency (<1%) arising on account of its isotropic emission, interference by scattered light, photo-bleaching of the fluorophore and a congested fluorescence emission spectrum on account of spectral broadening. In this context, Surface Plasmon-Coupled Emission (SPCE) platform presents a synergy of plasmonics and fluorescence technologies with innovative outcomes. The special characteristics of SPCE are: (a) 10-14 fold fluorescence emission enhancement resulting from coupling of >50% of the total fluorescence emission with the surface plasmons; (ii) increased collection efficiency resulting from a highly polarized directional emission; (iii) background suppression resulting from the use of a small sample volume. However, SPCE measurements have so far been carried out in laboratory conditions, far from being a point-of-care technology. Towards this end, we have pioneered the journey of a home-built platform to a low-cost, mobile phone based next-gen plasmonics technology. To our knowledge, for the first time in India, the SPCE platform has been fabricated and tested for different hand-held device applications, as part of this doctoral research.

In this doctoral work, we have focused on achieving higher enhancements, significantly reducing sample preparation time and fabricate a low-cost technology. The technical outcomes of this research are-

1) A simple 1-minute cavity engineering protocol that significantly improved the enhancements in fluorescence emission than conventional SPCE.
2) Tunable fluorescence enhancements with a wide variety of nanomaterials that span: metals, ceramics, low-dimensional carbon substrates and bio-materials.
3) Mobile phone based next-gen plasmonics platform.

The significance and uniqueness of this research work lies in the listed deliverables:
1. In excess of 1000-fold enhancement in fluorescence emission.
2. Use of Purcell factor as a tunable metric for SPCE.
3. Nanomolar detection of Tryptophan.
4. Picomolar quantification of coronary heart disease marker.
5. Femtomolar sensing of an organic dye.
6. Attomolar detection of DNA.
8. Multi-analyte sensing on mobile phone based SPCE platform.