High-throughput testing of the nanophotonic devices

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Abstract: The proposed Resonance Scattering Spectroscopy (RSS) technique is fully automated, non-invasive, and high throughput wafer scale characterization system. In the RSS technique, a laser broadband light source of fixed polarisation is tightly focused on the device under test. Light with a wavelength matching that of the device's resonance wavelength is scattered into the orthogonal polarisation giving a signal that is characteristic of the resonator which can be rapidly acquired. Using this prototype, several Photonic Crystal L3 cavities have been studied and we achieved a Q-factor of the order of tens of thousands for an optimised L3 cavity, which compares well with the design and simulation results.

High-Q nanophotonic resonator devices such as gratings, planar photonic crystal (PhC) cavities and ring resonators are increasingly gaining importance in various research areas like nanophotonics, biological sensing, non-linear optics, cavity quantum electrodynamics etc. One of the bottlenecks in commercially deploying such resonators is the lack of wafer-scale characterisation techniques. The other large-scale approaches for such characterisation are internal light source method [1], evanescent coupling to an optical waveguide [2], grating couplers [3]. However, they are limited by the optical absorption and the pump-induced losses of the active medium in the first case and complicated experimental geometry and the induced loading effect on the cavities in the latter cases. To overcome these challenges, we are developing a wafer scale optical characterisation of PhC cavities based on Resonant Scattering (RS). This is a fast and non-destructive technique and allows to determine the Q-factors of the resonators without loading effect [4]. Moreover, it does not require extra fabrication steps, thus making highly suitable for wafer scale characterisation.

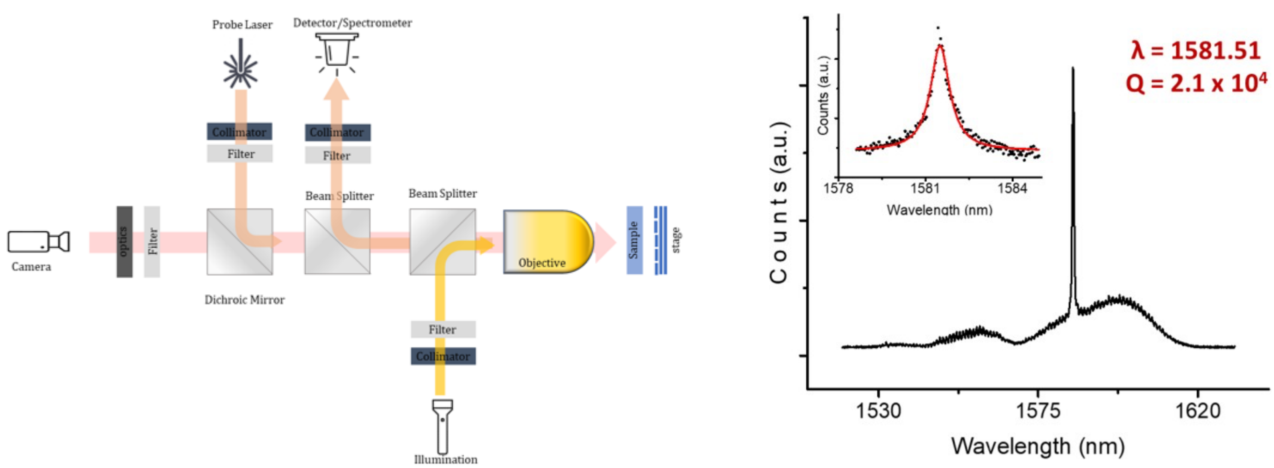

Figure 1. a) Schematic of Resonant Scattering experimental set up b) Resonant spectra of a PhC L3 cavity

The resonant scattering set-up is illustrated in Fig. 1. Light from a tuneable laser is passed through the polarizing beam splitter (PBS) and tightly focused on the sample by a means of polarization-preserving objective lens of high numerical aperture. The light scattered backwards is collected by the beam splitter and analysed in crossed polarization by analyser (A). This technique is so far implemented in the lab-scale characterization of the nanophotonic devices. To scale this set-up for wafer scale characterisation, high-accuracy translation stage controls and image recognition programs are being developed which can achieve testing of thousands of cavities in a day, thus solving an important bottleneck characterising these devices.

References

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