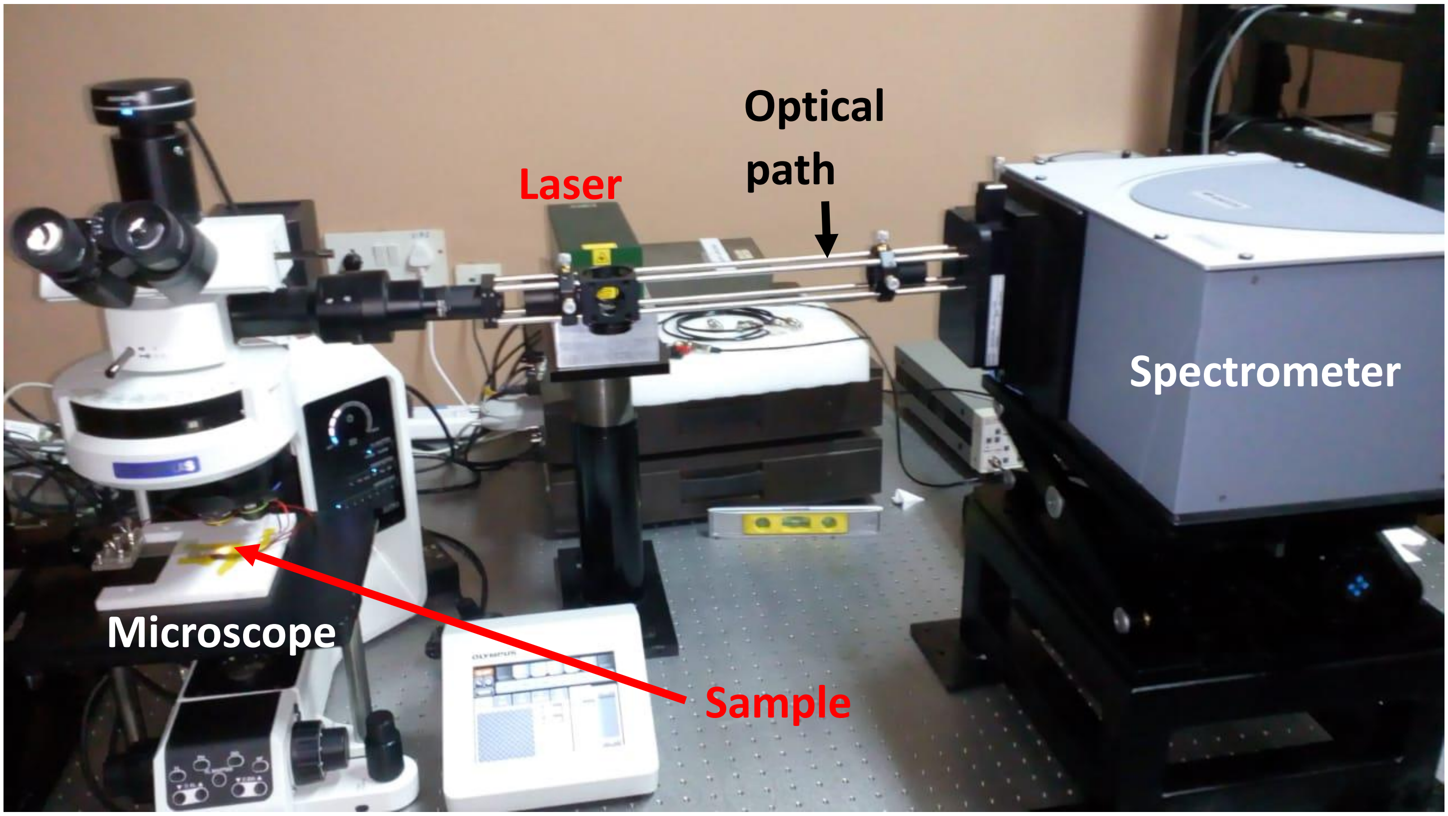
Glimpse

Micro-Photoluminescence set-up



Photoluminescence Spectroscopy (PL)

Introduction

Photoluminescence (PL) spectroscopy is a very efficient, contactless, non-destructive, widely used technique for the analysis of the optoelectronic properties of semiconductors, which requires very little sample manipulation. Photoluminescence is defined as the spontaneous emission of light from a material under optical excitation and can be therefore used to provide detailed information on discrete electronic states involving both intrinsic optical processes and about the wide variety of defect which are endemic in practical semiconductor materials and extrinsic optical processes (internal transitions involving defects and their energy levels) by applying an external light with energy $h\nu \geq E_G$; where E_G denotes the energy band gap, and observing the re-emitted photons.

The main uses of photoluminescence are:

1. Understanding of recombination mechanisms: Analysis of photoluminescence helps to understand the underlying physics of recombination processes.
2. Identification of surface, interface, and impurity levels,
3. Band gap determination: Most common radiative transitions in semiconductors occur between states in the conduction and valence bands, with the energy difference known as band gap E_G.
4. Assessment of the material quality: Material quality can be measured by quantifying the amount radiative recombination, keeping in mind that nonradiative recombination is associated to localize defect levels that are detrimental to material quality and subsequently to device performance.
5. Detection of defect and impurity levels: Radiative transitions can also involve localized defects and the photoluminescence energy associated to these levels can be used to identify these specific defects.

However, photoluminescence has some fundamental drawbacks such as:

1. Study of deep states: The inefficiency of studies of recombination mechanisms at very deep centres, where any radiative transitions give very broad spectra due to strong phonon coupling.
2. Non-radiative processes: Its reliance only on radiative processes makes materials with weak radiative activities (low quality indirect band gap) very difficult to study.

Set-up and various components:

1. 532 nm CW Laser as a light source.
2. Si CCD camera and detector.
3. Microscope (50X) for probing precise location on the sample
4. Optical cable.
5. PC and software.