Implementation of a Spectral PL Imaging System using a Tuneable Filter

Ms. Srinidhi Rajagopalan
Supervisor: Dr. Yameng Cao (Higher Research Scientist, NPL)

Introduction

Two dimensional nanomaterials are a special collection of materials that have a thickness of only a single unit cell (<1 nm). Unsurprisingly, this leads to many highly applicable traits such as a high degree of anisotropy and surface to volume aspect ratio, unique chemical functionality and their mechanical pliability to change into newer structures with different set of useful traits. In order to define the mechanical and optical identity Hyper Spectral Imaging (HSI) is used. It is a spectral imaging technique that uses every pixel in an image to collect and process information within a select spectral band in the electromagnetic spectrum. It is achieved by combining each of these pixels to form a three-dimensional image where it has two spatial dimensions and one wavelength dimension. But, the fundamental disadvantage of HSI, is that it is expensive and highly complex. It requires extremely sensitive detectors and large data storage devices for analyzing the hyperspectral data. But, using a single broadband tunable filter allows one to achieve hyperspectral imaging, without a spectrometer and grating, which is typically required in traditional HSI. This alteration can potentially yield higher spectral resolution, superior accuracy and requires the angular control over only, a single filter!

Method

Characterising the spectral response of an imaging system is important, because the camera measures a spectral convolutions of the system's spectral response and the sample's actual spectrum. A broadband reference light source with known spectra was used to characterise the spectral response. An optical bandpass filter (BPF) was mounted in the optical path between the source and the camera, its angle of incidence controlled using a stage. An integrating sphere fibre-coupled to a spectrometer measured the transmission spectrum of the filter, for a range of incidence angles. Deconvolution in the frequency domain was then applied, using the reference spectrum and the angular-spectral response was obtained. A bandpass filter (BPF) which is used to limit the bandwidth of the output emission was used to select specific wavelengths of the PL emission. The transmission efficiency of the bandpass filter was measured using a spectrophotometer. Images of the emission from the BPF provided the variation of emission intensity with respect to the change in angle of the BPF. From this data the PL emission can be constructed piece by piece.

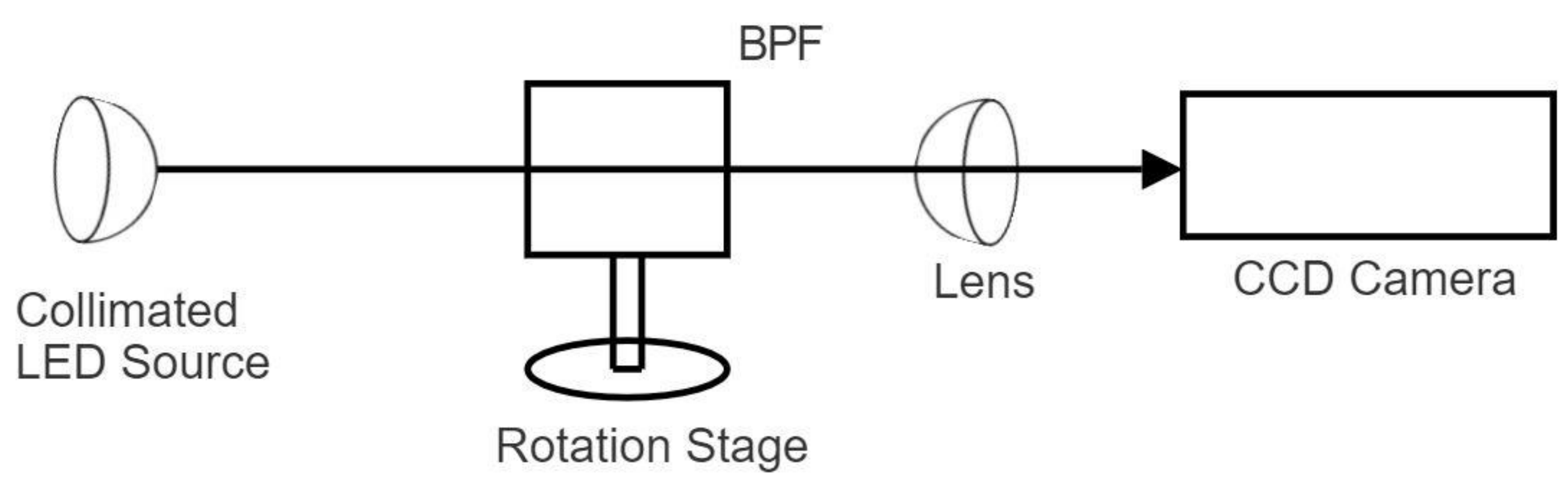

Fig 1. Hardware setup for Hyperspectral

Conclusion

The spectral response of the system was thus measured as shown in Fig 2. The part of the project that was tackled during the internship was to find an efficient way to define the transmission efficiency of the BPF and to setup a system to measure the PL emission from WS2 that was entirely managed by a LabView program. Though the results obtained were reliable, further understanding of how introducing a focusing system into it will enhance the setup's ability to better capture the emission. With adequate programming of all the components, this system can be employed in the production line for integrated circuits with wafer scale materials for quality control and quality assurance.

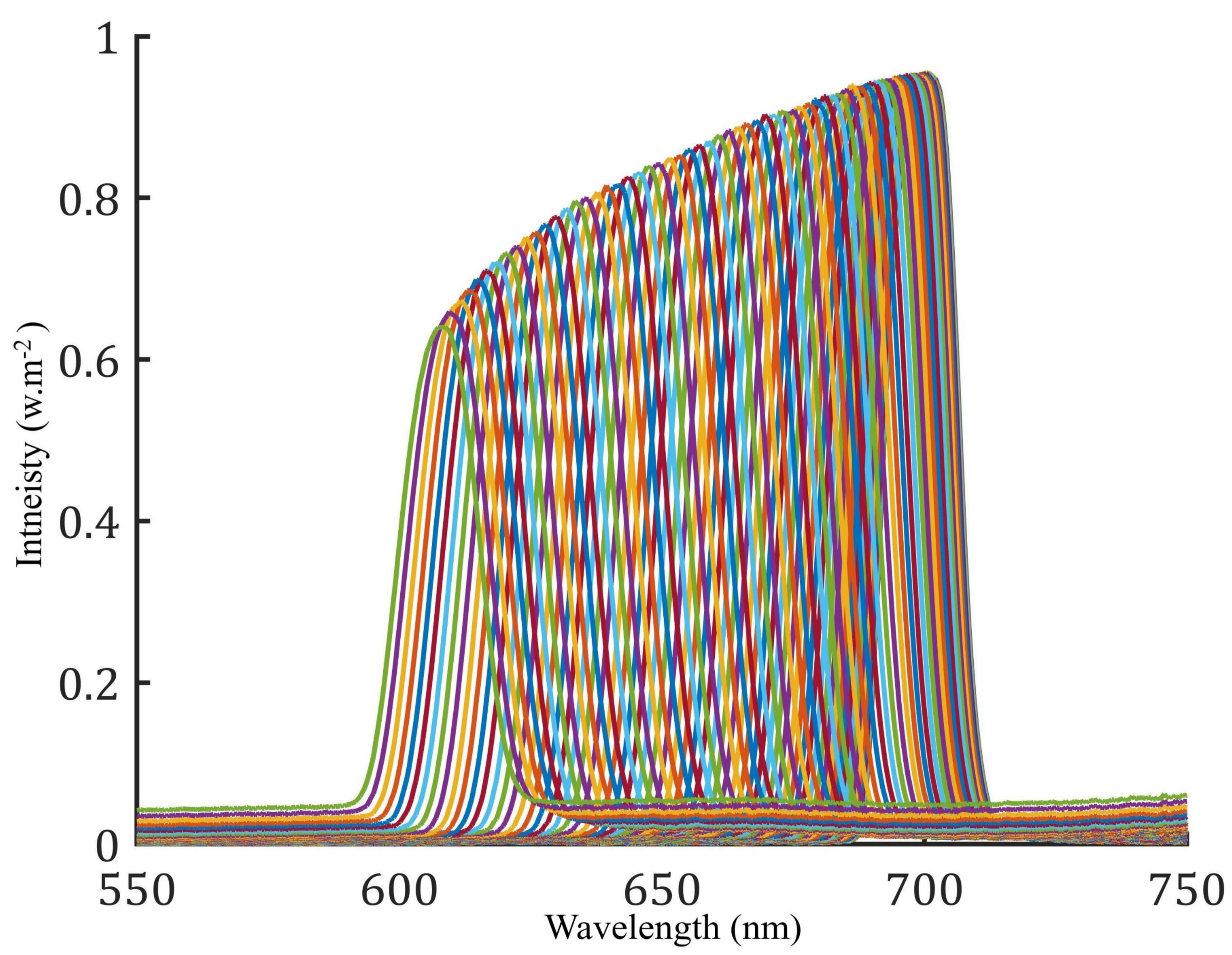

Fig 2. Measured Spectral Response for WS2