NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2019-2020

Hanbury Brown and Twiss experiment in an electron microscope: Application to luminescence lifetime mapping at the nanoscale

General scope:
More than two decades have passed since the first demonstration of blue gallium nitride (GaN)-based light-emitting diodes (LEDs). Today, blue and white LEDs have achieved much higher efficiencies than competing technologies and billions of these LEDs are produced every week. By combining aluminium nitride (AlN) with GaN in an alloy, the wavelength of LED emission can be tuned in ultraviolet (UV) over a spectral range from 210 nm to 400 nm. Compared to conventional UV sources, such as mercury lamps, UV LEDs offer a number of advantages. They are extremely robust, compact, and environmentally friendly and have very long lifetimes. However, despite sustained research efforts, the efficiency of UV LEDs remains limited (< 1% for deep-UV LEDs compared to more than 80% for blue LEDs). Indeed, several technological barriers still limit their efficiency: structural defects, difficult doping, and inefficient light extraction...In order to establish the relationships between efficiency and material characteristics, it is necessary to have a precise knowledge of the efficiency of these emitters at a nanoscale.

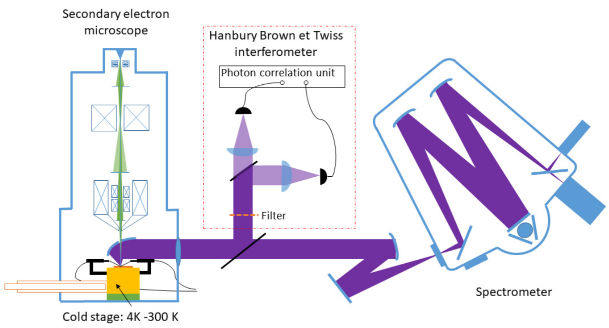

Figure 1 -Schematic diagram of the CL setup as well as the photon correlation module

Research topic and facilities available:

In this context, we develop a new method to measure the decay time in the UV range with a temporal resolution of 50 ps while having a spatial resolution of 50 nm, for temperatures ranging from 4 K to 300 K. To achieve this objective, we use a Hanbury Brown and Twiss interferometer coupled to a cathodoluminescence system in a scanning electron microscope. This interferometer will make it possible to analyze the statistics of photons emitted by cathodoluminescence. By taking advantage of the specificity of electron excitation, this technique allows the study of the luminescence decay time for any type of material. During his/her internship, the student will start by studying state-of-the-art quantum well-based UV LEDs. Then, he/she will study the efficiency of NW-based UV LEDs developed in Grenoble by Bruno Daudin (CEA-IRIG). Finally, he/she will use this experimental setup to characterize unique photon sources emitting in the deep UV.

Possible collaboration and networking: This work will involve collaborations with researchers from CEA Grenoble and Germany.

Possible extension as a PhD: Several funding opportunities are available. Please contact us for more information.

Required skills: The candidate should have a master 2 in Nanosciences or equivalent, with a marked interest in experimental physics, material growth and characterization.

Starting date: Flexible

Contact: Gwénolé JACOPIN, Institut Néel - CNRS
Phone: +33 4 76 88 11 83 e-mail: gwenole.jacopin@gmail.com

More information: http://neel.cnrs.fr

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