Room-temperature single photon emitters in GaN

Jesus ZUNIGA-PEREZ, jzp@crhea.cnrs.fr, 0493954309

Single photons are the backbone of many quantum information technologies [1]. These comprise quantum computation schemes [2], quantum information processing [3] and, especially, quantum communications [4], where photons are used as flying qubits between nodes of a larger quantum communication network. Since in these architectures we aim for long communications distances, the ideal operation wavelengths happen to be those compatible with low-loss optical fibers, i.e. telecommunications wavelengths (1.3\(\mu\)m or 1.55\(\mu\)m).

Currently, many of these demonstrations are carried out using heralded single photon sources based on parametric downconversion. However, to prevent multiple-photon contributions (i.e. more than one photon per pulse) these sources are strongly attenuated, reducing the probability of single-pair generation to typically less than 10\% and limiting the maximum communication rate. In this context, the development of an on-demand, high-purity, high-brightness and large repetition rate single-photon source is highly desirable [5].

Very recently, in the period 2017/2018, four groups identified optically-active defects in standard GaN thin films emitting single-photons up to room-temperature: first in the 650nm–750nm wavelength range and then in the 1.1–1.4 \(\mu\)m wavelength range, which was explored by the NTU collaborator of CRHEA [6]. They showed that the SPS were randomly distributed all over the sample, with zero phonon lines spanning the range from 1085nm to 1340nm. At room-temperature, these sources display second order autocorrelation functions at zero delay ranging from 0.05 to 0.15. Most importantly, the maximum count rates typically observed in these samples are in the order of 10^6 counts/s, which place them among the brightest single-photon sources from bulk crystals.

Based on these observations, at CRHEA we plan to fabricate an electrically-injected single-photon source operating at room-temperature.

The objectives of the “stage de master” will be to:

1. Fabricate GaN thin-films emitting single photons by metal-organic vapour phase epitaxy and to control the density of the structural defects mediating the single-photon emission.

2. Characterize, from an structural and optical point of view, the defects associated in the single-photon emission. To do so, the student will conduct photoluminescence and cathodoluminescence measurements on the GaN thin-films and will assess thereby the density of stacking-faults.

References: