DF
DEPARTAMENTO
DE FÍSICA
TÉCNICO LISBOA

Nanotechnologies and Nanoelectronics

2021-semestre 1-P2

Homework #4

The work should be sent to: susana.freitas@tecnico.ulisboa.pt

Deadline: 4 February 2022 @ 23:59[1].

Please send the work in one single file[2] (e.g., pdf, jpeg, word) identified as: **NN2021_YourName_HW4**

[1] The documents received up to 5 days after the deadline will have a penalty of 1 point (out of 20) per day. No documents will be accepted after the 6th day.

[2] In case you need to have pictures of hand-written work, or multiple format digital formats for your solutions, please merge them into one single document.

Internal quantum efficiency and nonradiative recombination coefficient of GaInN/GaN multiple quantum wells with different dislocation densities

(Dai et al. Appl. Phys. Lett. 94 (2009) 111109)

1. The authors use a 405 nm laser for photoluminescence (PL) measurements. To which energy does this wavelength correspond (show the calculation)?
   Compare this energy value to the bandgaps of GaN and InGaN (assuming the composition of InGaN quoted in the paper and a linear dependence of the bandgap of $In_xGa_{1-x}N$ from 3.4eV (for x=0) to 0.6 eV (for x=1)).
   Why do the authors choose this energy for their study instead of exciting the layers with a laser energy above the bandgap of GaN (which would be more similar to driving the LED electrically)?

2. Why does the internal quantum efficiency (IQE) decrease for increasing threading dislocation density?

3. Using the ABC model described in the paper and considering all recombination processes, plot the IQE of the sample with highest threading dislocation density as a function of the carrier concentration n from 10^{17} to $5x10^{19}$ cm^{-3}.
   What is the highest IQE and at which n does it occur? Explain the drop of IQE for higher and lower n.