

# Semiconductors & Optics: an introduction.

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The aim of this lecture is to introduce the fundamental concepts needed to understand and analyse the operation of current and future optoelectronics devices. A particular attention will be paid to photodetectors and Light Emitting Devices (LED), as recent advances in the development of these technologies will be discussed in more details by other authors during this summerschool.

The first section will review the useful notion of semiconductor physics. First of all, the concept of band structure in bulk and hetero-structure will be summarized. Then, the basic theory of radiative recombination will be presented, allowing to model both absorption, spontaneous and stimulated transitions in bulk semiconductor in the presence of light. The impact of the band structure on absorption or emission will be qualitatively discussed, introducing the concept of band engineering. Moreover, the concept of exciton will be also briefly introduced.

In a second section, two critical physical effects impacting the operation of opto-electronical semiconductor devices will be presented: defects and contacts. The concept of shallow and deep traps will be presented, based on the theory of Shockley Read Hall. Then, the injection or collection of charges at contact will be discussed.

Finally, the main figures of merit of LED and photodetectors will be introduced, including quantum efficiency, response time and noise. Last but not least, the concept of light extraction (for LED) or injection (for photodetectors) will be reviewed, introducing to concept of thin-film optical filters. It will used to present the design Distributed Bragg reflector (DBR) and Resonant Cavity LED.

This lecture will help understanding the other presentations of the summerschool on silicon photonics, guided optics, imagers and light emission in III V semiconductors.

## Bibliography :

- [1] Charles M. Wolfe, Nick Holonyak, G. E. Stillman, "Physical properties of semiconductors", Prentice Hall, 1989 - 354 pages
- [2] E. Fred Schubert, LIGHT-EMITTING DIODES, 2<sup>nd</sup> edition, CAMBRIDGE UNIVERSITY PRESS, 2006
- [3] Bahaa E. A. Saleh, Malvin Carl Teich, "Fundamentals of Photonics", John Wiley & Sons (1991)