Department of Physics
Condensed Matter Physics
Clarendon Laboratory, Parks Road, Oxford OX1 3PU

UNIVERSITY OF OXFORD

CONDENSED MATTER SEMINAR

Thursday 24 October at 2.15pm

"A needle in a needlestack – exploiting functional inhomogeneity for optimized nano-optoelectronics"

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Over the past decade, integrated photonic devices have emerged as a platform with wide technological application. In such devices, a light source, waveguides, interferometers, non-linear optical elements and detectors are combined on a single chip; these have been demonstrated for machine learning, neuromorphic computing and as quantum optical platforms. Of these, efficient nanoscale light sources have proven to be the most challenging element primarily due to the difficulty involved in combining conventional laser technology (III-V semiconductors) with the CMOS compatible technology preferred by industry.

A promising solution for integrated coherent light is using III-V semiconductor nanowires. These structures allow easy hetero-integration onto silicon due to efficient strain relaxation, well-understood design approaches and scalability, however to date, silicon-integrated continuous room temperature lasing has proven elusive. One key reason for this has been the challenge in repeatable characterisation – each wire can be different due to local growth conditions. In this talk, I will speak about both our attempt to address this, and to use large-scale population studies to exploit inherent inhomogeneity to understand the complex interplay of geometric design, crystal structure, and material quality to produce high yield, low-threshold nanoscale light sources.

I will focus on three element of this study – correlation analysis to identify the limiting design element in nanolasers[1], material optimization for high quantum efficiency via doping[2], and cavity analysis using novel time-resolved interferometry[3,4]. Each study has enabled record low optically pumped thresholds for III-V nanolasers towards room-temperature continuous lasing.

1. Alanis, J. A. et al. *Nano Lett.* **17**, 4860–4865 (2017).
2. Alanis, J. A. et al. *Nano Lett.* **19**, 362–368 (2018).
3. Zhang, Y. et al. *ACS Nano* **13**, 5931–5938 (2019).
4. Skalsky, S., Zhang, Y., Alanis, J. A., Liu, H. & Parkinson, P. *{In prep.}* (2019).

Host: Prof Laura Herz

Simpkins Lee Room, Beecroft Building