UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"NANOPOROUS SILICON AND ITS APPLICATIONS"

Prof. Leigh Canham

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Short Abstract:

The objectives of this course are to:

- Introduce you to typical properties and uses of porous materials in general, and nanoporous silicon in particular
- Survey why the semiconductor silicon has been such an influential material, shaping modern society
- Demonstrate how nanostructuring a material can both radically change its properties and provide size-tunability of properties
- Talk about the challenges of nanotechnology, using nanoporous silicon examples, such as the need for more sustainable ("green") synthesis and nanomaterial stability and cost
- Survey a broad range of applications being investigated for this nanomaterial from both a technical and commercial perspective

The course will particularly suit those students who have an interest in multidisciplinary science, nanotechnology and entrepreneurship.

Course Contents in brief:

- **Introduction to porous materials :** Classes of porosity. Characterization techniques. Applications of porous metals, ceramics, organics.
- **Introduction to silicon technologies:** Electronics to nanoelectronics. MEMS. Solar power.
- **A brief history of porous silicon:** Mr & Mrs Uhlir. FIPOS. Visible luminescence. Multifunctionality. Academic and industrial activity.
- **Routes of synthesis**: Electrochemical etching. Magnesiothermic reduction. Dealloying. Green synthesis. Other techniques.
- **Properties:** Tuning via porosity, composition and quantum mechanics. Mechanical. Thermal. Optical. Luminescent. Magnetic composites.
- **Processing:** Substrates, membranes, particles or composites? Techniques for patterning, passivating, pore loading and communition.

- **Electronic applications:** Electrical or thermal isolation of circuitry. Uses in micromachining and MEMS.
- **Analytical applications:** Gas sensing. Biosensing. Mass spectrometry. SERS Analysis.
- **Optoelectronic applications:** Waveguides. LEDs. Photonic crystals.
- **Energy applications:** Solar and fuel cell uses. Anodes in Li batteries. Supercapacitors. Thermoelectrics. Explosives. Hydrogen storage.
- **Medical applications:** Medical device and pharmaceutical industry. Brachytherapy. Imaging. Drug delivery. Wound repair. Orthopaedic tissue engineering.
- **Other applications.** Toothpaste. Nutraceuticals, Cosmetics. Emerging uses.

Total # of hours of lecture: 20

References:

[1] "Nanoporous silicon as a green high tech educational tool" J.L.Coffer & L.T.Canham. Nanomaterials 11,553 (2021).

[2] Handbook of Porous Silicon. Edited by L.T.Canham. Springer Reference Textbook (2014,2017)

CV of the Teacher

Leigh Canham is Professor of Nanomaterials for Biomedicine and Photonics at the University of Birmingham, UK. He is a scientist devoted to finding novel properties and uses for the semiconductor that has already transformed our everyday lives. Leigh has over 30 years' experience conducting R&D on widely differing aspects of silicon technology. Two key personal research discoveries – that silicon can emit visible light efficiently (1990) and be rendered medically biodegradable (1995) have had significant academic and commercial impact. Over 25,000 citations have been made to his 196 publications and multiple companies have started to operate within the fields of his 100 granted patents. Leigh has 15 years' experience of start-up company management, right through from co-founding with seed VC finance, to NASDAQ listing. He has served as Chief Scientist on the board of two companies based in England, one in Singapore, and one in Australia. From 1999-2016 he held an Honorary Professorship at the University of Birmingham for his work on luminescent silicon. In 2011 Leigh was a shortlisted finalist for the "European Inventor of the Year" Award from the European Patent Office for his work on biodegradable silicon. In 2012 he became a Thomson Reuter Citation Laureate for his work on luminescent silicon. The Federation of European Materials Societies awarded him the 2015 Materials Innovation Medal and he received the Spiers Memorial Medal from the Royal Society of Chemistry in 2020.

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:
December 13th, 2021, 9:00 – 13:00
December 14th, 2021, 9:00 – 13:00
December 15th, 2021, 9:00 – 13:00
December 16th, 2021, 9:00 – 13:00
December 17th, 2021, 9:00 – 13:00