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

UNIVERSITY OF OXFORD

CONDENSED MATTER PHYSICS SPECIAL SEMINAR

Monday 15 June at 15:30
Simpkins Lee Seminar Room, Department of Physics
(https://maps.app.goo.gl/WjG71uLF2D48n85B6)

Quantum Materials and Processes for Complex Microsystems on Silicon

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Materials and processes for complex microsystems (MEMs, microbots, opto-electronics, etc.) on silicon are very much in vogue today. Novel ways to integrate different materials and processing them with ease on silicon are key to this goal. My research is focused on the use of pulsed laser deposition (PLD), a technology being accepted by the semiconductor industry, to grow crystalline functional materials on silicon for a variety of applications ranging from quantum information systems, opto-electronics and heterogeneous integration. There are significant challenges currently with optical qubits based on color centers, namely nuclear hyperfine interaction induced decoherence, lack of scalability to large areas, precise location of the qubits and difficulty in nano-structuring the host materials. We are working with CeO_2 (with zero nuclear moment) and developing a layer-by-layer growth (and doping) process on silicon to help with scalability and qubit spatial accuracy. Another interesting quantum material is Cu_2O which is a very difficult material to grow as a smooth, single crystalline thin film. Because of the high energy exciton in this material system, high order Rydberg states are accessible and in photoluminescence we can resolve up to n= 6 while in absorption spectroscopy higher order states may be accessible. We have developed a buffer layer scheme for the growth of a variety of crystalline functional oxides on silicon. Since many of these oxides are not easy to etch using reactive ion etching, we have invented a novel process, **PLATEN** (**P**ulsed **L**aser **T**emplate **E**ngineering) whereby these functional films are deposited using PLD on pre-patterned silicon wafers whereby the deposited films take the exact shape of the patterns leading to an easier way to fabricate opto- electronic devices. Reactive ion etching of silicon is a highly evolved process owing to its importance to the silicon industry and we leverage this technology here. We are also manipulating oxide heterostructures to introduce new functionalities and I will discuss recently discovered ferroelectricity in a highly unlikely combination of materials.

Host: Dr Hariom Jani