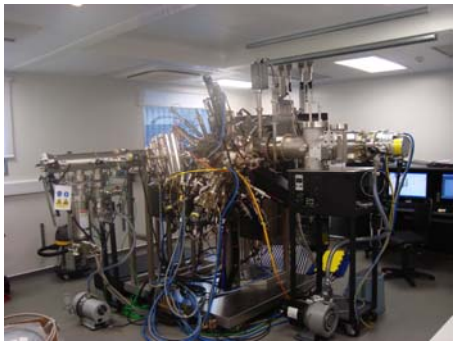
Molecular Beam Epitaxy System and Si-Photonics Materials and Devices

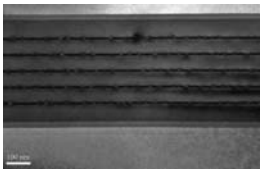
New III-V Molecular Beam Epitaxy System

•One of the most important growth facilities to grow epitaxial semiconductor materials for semiconductor optoelectronic devices, such as lasers, emitting diodes, detectors, and modulators.
•Ultra-High-Vacuum-based technique (base pressure <1x10^{-13}bar) for producing high quality epitaxy structures with sub-monolayer control to produce Nano-photonic materials and devices.
•Mainly develop semiconductor materials and devices to support the research on Si photonics, Nano-photonics, and solar cells.
•Provide semiconductor materials and devices to other research groups at UCL and London Center for Nanotechnology.
•11 sources with aim to grow a wide range of III-V materials and devices for communication and energy applications with As-, P-, and Sb-based materials on III-V, Ge and Si substrates.
•Commissioned at July 2010.

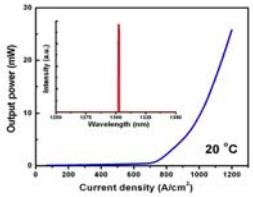


III-V Quantum-Dot Laser on Si substrate

•The key issues for III-V metamorphic buffer on Si substrate is to smooth the surface roughness and to suppress the dislocation formation.
•QD devices are less sensitive to defects. This makes III-V QD emitters to be the most promising candidate for integrating III-V lasers on Si.
•First operation of an electrically-pumped 1300-nm InAs/GaAs QD laser epitaxially grown on Su substrate was demonstrated at 2011.



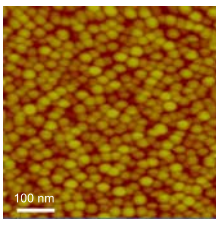
TEM picture of InAs/GaAs QDs on Si



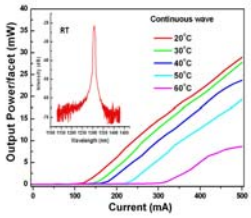
InAs/GaAs QD laser on Si substrate

III-V Quantum-Dot Laser on Ge Substrate

•Direct epitaxial growth III-V on Si has been working on for 30 years.
•Ge on Si virtual substrate could offer better alternative for direct III-V epitaxy on Si with low defect density.
•New growth technology was developed for GaAs growth on Ge at UCL.
•First QD laser grown on Ge was demonstrated by the technology.



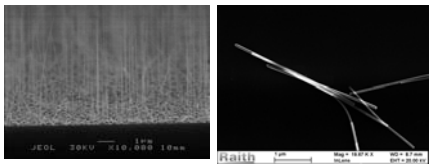
AFM picture of InAs/GaAs QDs on Ge



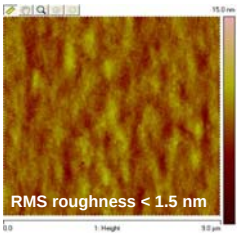
InAs/GaAs QD laser on Ge substrate

Other Capacities of MBE System

•High-quality InP-lattice-matched InGaAsP, InGaAlAs, AlAsSb, and GaAsSb layers on InP substrate.
•High-quality GaSb layer grown on Si substrate.
•Catalyst-free GaAs, GaAsP, GaAsSb, InAs, and InAsP nanowires grown on Si substrate.



SEM images of 1.7-eV GaAsP nanowires on Si substrate for high-efficiency solar cells



300-nm GaSb grown on Si

Key Publications

•Huiyun Liu, Ting Wang, Qi Jiang, Richard Hogg, Frank Tutu, Francesca Pozzi, and Alwyn Seeds, "Long-wavelength InAs/GaAs quantum-dot laser diode monolithically grown on Ge substrate", *Nature Photonics* **5**, 416 (2011)

•Ting Wang, Huiyun Liu, Andrew Lee, Francesca Pozzi, and Alwyn Seeds, "1.3-μm InAs/GaAs quantum-dot lasers monolithically grown on Si Substrate", *Optics Express* **19**, 11381 (2011)

Acknowledgements

THE ROYAL SOCIETY CELEBRATING 350 YEARS
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[dstl]

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