Title

Epitaxy of Gallium Oxide quantum well semiconductor heterostructures on Sapphire

Description

The radio–frequency (RF) power electronics applications including electronic and photonic sensors based on silicon technology have already reached their potential limits. The emergence of wide bandgap (WBG) materials such as silicon-carbide (SiC) and gallium nitride (GaN) brought new opportunities enabling compact and more efficient electronic devices. However, the push toward even higher frequency operation and increased power densities is driving the urgent need for new class of materials. Gallium oxide (Ga_2O_3) has been marked as ultra-wide bandgap (UWBG) material, next to the wide bandgap SiC and GaN materials to be extensively utilized for the sensors and RF power conversion applications in future electric vehicles and energy harvesting systems. Although the mobility of the bulk Ga_2O_3 reported in the literature is lower than those of well researched compound semiconductors, the cubic dependence of DC conduction loss on electric field breakdown allows superior switching performance and outstanding figure of merit. In the last five years, Ga_2O_3 has attracted great interest due to a combination of its unique material properties and native substrate availability. However, enhancement of electron mobility utilising quantum effects has not been researched in this material, yet.
This PhD project is an exciting opportunity to be involved in an innovative and pioneering research on epitaxy of Ga_2O_3 quantum well (QW) heterostructures and basic research of their properties. The overall aim is to demonstrate the world's 1st strained Ga_2O_3 QW heterostructure, on cost-effective c-plane sapphire substrate, with coexistence of modulation doping and strain induced layer to enhance electron mobility and understand its scattering mechanisms. The experimental results will add greatly to the knowledge of materials science, condensed matter physics and physics of UWBG semiconductors; and enable a wide range of electronic, photonic and sensor device architectures based on new class of emerging UWBG semiconductor materials. Epitaxial growth for this research will be carried out at Warwick University, using unique to the UK academia, Molecular Beam Epitaxy of gallium oxide. Characterisation of grown materials will be carried out in-house using a range of state of the art equipment and techniques including XTEM, SEM, AFM, HR-XRD, XRR, Raman spectroscopy, Spectroscopic Ellipsometry, FTIR, Hall effect and resistivity, etc. Electronic devices for measurements of pioneering transport properties of 2D electron gas (2DEG), including mobility, will be done in-house as well, using recently commissioned agile microfabrication facilities. The successful PhD candidate will work at the cutting edge of semiconductor research and collaborate closely with experts across academia and industry. The skills and experience learned throughout the PhD will make the candidate an expert in epitaxial growth, metrology and device fabrication, skills which can be transferred across the semiconductor and broader condensed matter fields. The project will involve collaboration with scientists from national and international. Successful outcome from the project would lead to high impact publications in international scientific journals, creation of IP with enormous impact potential and application of novel materials in a variety of power and RF electronic devices and sensors using capabilities of academic and industrial collaborators.

To discuss this project further contact:

Dr Maksym Myronov (M.Myronov@warwick.ac.uk)