Selective epitaxial growth of Silicon Carbide thin film materials

Supervisor: *Dr Maksym Myronov*, Department of Physics, The University of Warwick, UK

Silicon carbide (SiC) is a wide band gap compound semiconductor material attractive for future applications in high power and high frequency electronic devices, UV photonic devices and sensors including those for bio-medical, industrial, IoT and automotive sectors. Epitaxial growth of a semiconductor material thin film with thickness starting from sub-nanometre is an essential front end technology from which fabrication of any modern and advanced semiconductor device begins. In particular, selective epitaxial growth is the most advanced epitaxy technology enabled appearance of high end electronic and photonic devices widely used in everyday life. Selective epitaxy permits growth of a monocrystalline semiconductor material on a surface of another monocrystalline semiconductor surrounded by a non-crystalline material preventing epitaxy on its surface. Thus, the technology allows integration of different materials on the same substrate, and potentially could be a solution for very challenging heteroepitaxy of highly mismatched materials. Nowadays, selective epitaxy of silicon and silicon germanium materials is widely used to in production, development and research of modern and future devices. Such modern devices are inside of computers, smartphones and a large variety of electronic gadgets, and life without most of them is unimaginable. However, essential selective epitaxy of SiC has not been demonstrated yet. The reason for it is extremely high growth temperatures of SiC at which any mask material melts. Recently, a new low-temperature SiC epitaxy technology has been invented at Warwick University, which opens up the opportunity for selective epitaxy of SiC.

This PhD project is an exciting opportunity to be involved in innovative and pioneering research on selective epitaxial growth of SiC semiconductor material. Selective epitaxy physics of SiC is expected to be researched and understood. The project is based on recent ground breaking work demonstrated SiC epitaxy at low-temperature and leading to high impact research. The experimental information will add greatly to knowledge of materials science and condensed matter physics; and enable wide range of electronic, photonic and sensor device architectures. Epitaxial growth for this research will be carried out at Warwick University, using unique to UK academia industrial type Reduced Pressure Chemical Vapour Deposition equipment upgraded beyond state of the art. Patterned substrates for the selective epitaxy will be fabricated in house and supplied by industrial and academic collaborators. Characterisation of grown materials will be carried out in-house using a range of sate of the art equipment and techniques including XTEM, SEM, AFM, HR-XRD, XRR, Raman spectroscopy, Spectroscopic Ellipsometry, FTIR, Hall effect and resistivity, etc. The project will involve collaboration with scientists from national and international universities as well as with research groups from leading semiconductor companies. 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 developed selective epitaxy of SiC in a variety of power and RF electronic devices, and sensors using capabilities of academic and industrial collaborators.

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. These skills can be transferred across the semiconductor and broader condensed matter fields.