Electron Channelling Contrast Imaging of Defects in Nitride Semiconductor Thin Films

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Nitride semiconductor thin films are used in the manufacture of UV and blue laser diodes, UV and visible LEDs and white LEDs. Present applications of nitride LEDs extend from automotive and street lighting, to back lighting in mobile phones, to traffic lights. Future applications include replacing the light bulb in your home.

The performance of existing devices is limited by the presence of defects such as dislocations in the films. For example dislocations present in aluminium containing nitride thin films are thought to be responsible for the present low efficiencies of UV-emitting LEDs. Developing the capability to analyse dislocation densities rapidly with negligible sample preparation would represent a real step forward in the development of more efficient nitride semiconductor based devices.

In this presentation I will describe the use of electron channelling contrast imaging – in a field emission scanning electron microscope – to reveal and identify defects in nitride semiconductor thin films [1].

In electron channelling contrast imaging the intensity of electrons backscattered from a suitably oriented sample depends on the relative orientation of planes in a crystal. Changes in crystallographic orientation or changes in lattice constant due to strain are revealed by changes in grey scale of an image constructed by monitoring the intensity of backscattered electrons as an electron beam is scanned over the sample. Extremely small orientation changes are detectable, enabling defects (e.g., threading edge and screw dislocations) to be imaged due to lattice plane tilting and strain in the vicinity of the defects.

I will discuss our results in light of those obtained with transmission electron and atomic force microscopy. I will also discuss recent results obtained from our nitride thin films using electron backscatter diffraction and hyperspectral cathodoluminescence. I will discuss results from both c and m-plane GaN thin films and from InAlN/AlN/GaN hetrostructures.

[1] C Trager-Cowan, F Sweeney, P W Trimby, A P Day, A Gholinia, N-H Schmidt, P J Parbrook, A J Wilkinson and I M Watson, 2007, ***Electron backscatter diffraction and electron channelling contrast imaging of tilt and dislocations in nitride thin films***, Physical Review B 75, 085301.