Topography: Beta Cell

Characterization of $B_{12}As_2$ /(0001) 6H-SiC Epilayers for Beta Cell Applications

Beamline: X19C, PRT member

CFN
General User

Techniques:
White Beam X-ray Topography
HRTEM

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Motivation:

$B_{12}As_2$ is a semiconductor member of the icosahedral boride family based on clusters of boron atoms and two-atom As-As chains. It has a wide bandgap of 3.47eV and is potentially useful for devices operating in high electron radiation environments due to its radiation hardness. A unique potential application of $B_{12}As_2$ is for beta cells, a device capable of direct nuclear to electrical energy conversion.

Using synchrotron white beam X-ray at X19C, we are able to determine the growth orientations of $B_{12}As_2$ epitaxial films grown on various SiC substrates and examine the quality of the films.

Experiment:

- Transmission mode X-ray topography was performed on the samples containing $B_{12}As_2$ epilayers grown on c-plane 6H-SiC substrates.
- High resolution TEM of epilayer cross-sections

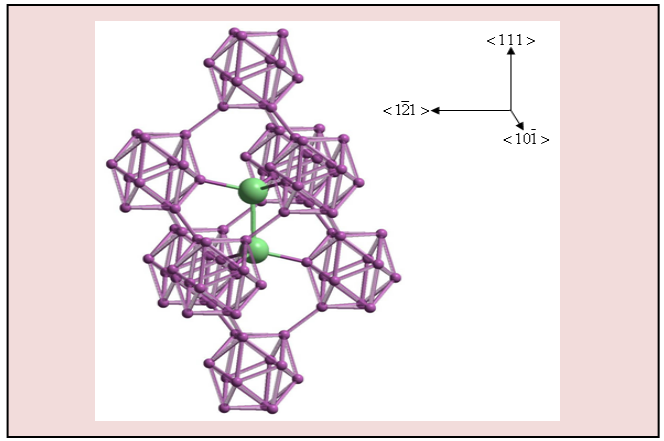

Figure 1 $B_{12}As_2$ unit cell viewed closely along <10-1 > showing boron icosahedra and an As-As chain. The smaller purple atoms are *B* and the large green ones are *As*.

Results:

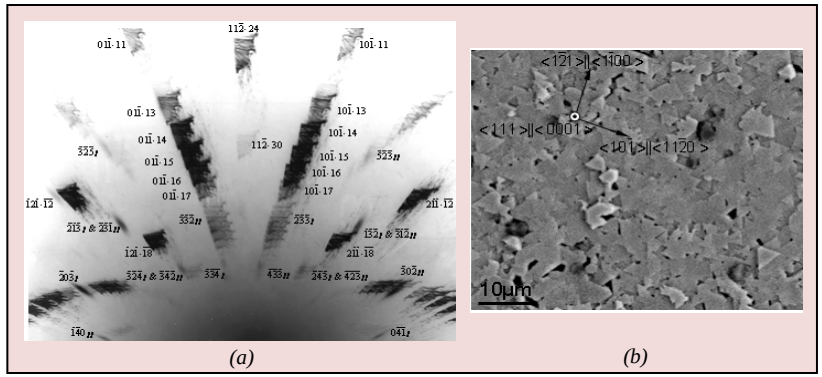

Figure 2 *(a)* X-ray Laue pattern of $B_{12}As_2$ grown on c-plane 6H-SiC substrate. (b) SEM image showing surface morphology of B12As2 epitaxial layer on c-plane 6H-SiC.

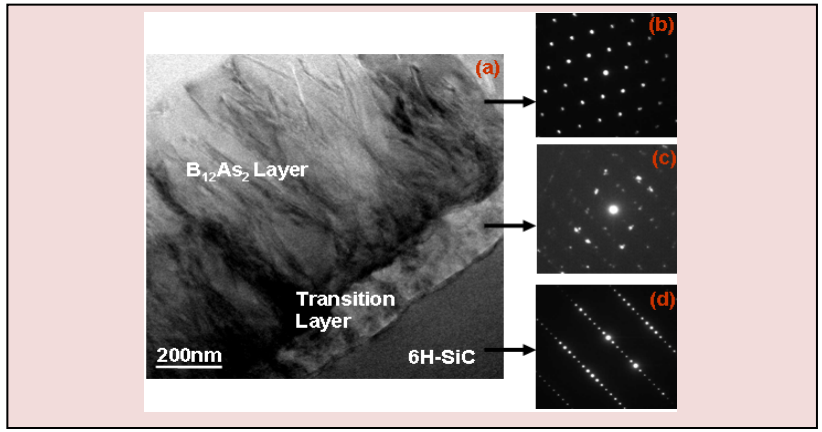

Figure 3 (a) Cross-sectional TEM image taken along <11-20> $B_{12}As_2$ revealing a transition layer located between the $B_{12}As_2$ layer and the 6H-SiC substrate. Comparison among the diffraction patterns of the $B_{12}As_2$ film (b), the $B_{12}As_2$ transition layer (c) and the 6H-SiC substrate (d) showing the relative disorder in the B12As2 transition layer.

- The basic epitaxial relationship was found to be (111) $B_{12}As_2$ <10-1> $B_{12}As_2$ ||(0001)6H-SiC<11-20>6H-SiC.
- A quite homogenous solid solution of twin and matrix epilayer domains forming a submicron mosaic structure is present in the epitaxial film.