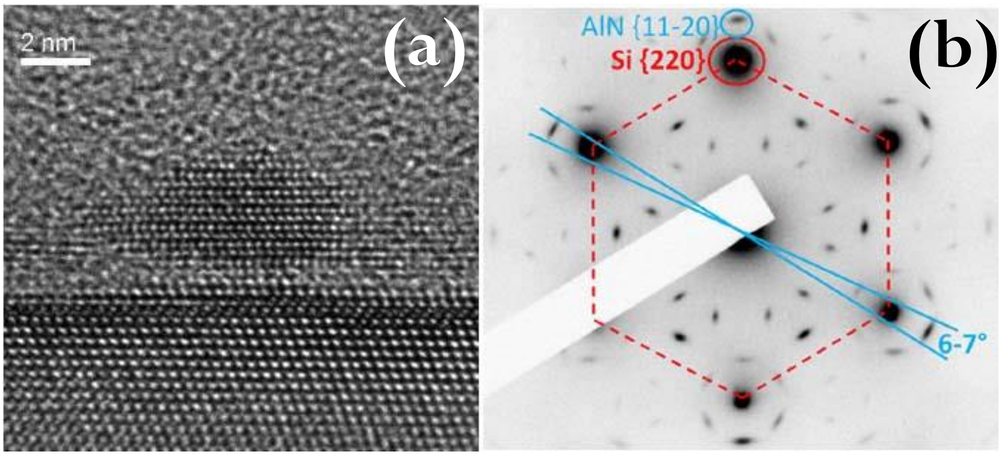
Towards the comprehension of dislocations generation in epitaxially-grown (0001) wurtzite layers

Common Research Service (SCR)



(a) Side view of an AlN island deposited on Si (111).

(b) Top view electron diffraction pattern revealing the twist between AlN islands.

Why twisted columns in wurtzite thin films?

Materials with a hexagonal wurzite structure (III-Nitrides, ZnO-based…) have a lot of applications in optoelectronic and microelectronic. Due to the lack of available large size and low price substrates, wurtzite films are most of the time heteroepitaxially-grown on foreign substrate. The microstructure of these films is dominated by threading dislocations which have detrimental effects on their properties and whose origin remains unclear. Our study of the growth of AlN on Si (111) allow us to propose a model explaining their formation. Firstly, AlN growth is 3D with the formation of relaxed islands. The relaxation occurs trough the introduction of in-plane mixed dislocations. The screw components of these dislocations induce the twist of the islands. The angle distribution of the twist may be quantitatively correlated to the lattice mismatch between the deposited film and the substrate. Threading dislocations are formed at the coalescence of the 3D-islands to compensate their relative twist. Their density depends on the islands twist (intrinsic to a material system) and size (growth dependent).

Breakthroughs

We propose an original model explaining the twist of crystalline domains in wurtzite films and therefore the origin of threading dislocations.

Perspectives

The proposed model has been quantitatively verified for AlN on Si (111). The study has to be extended to other wurtzite films/substrate systems with different lattice mismatches.

Collaborations : CEA-LETI ; CNRS-C2N

More information : *N. Mante et al., J. Appl. Phys.,* ***123****, 215701 (2018)*

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