High quality (11-22) semipolar GaN nearly free of basal stacking faults grown on 2 in. patterned sapphire substrate by MOCVD

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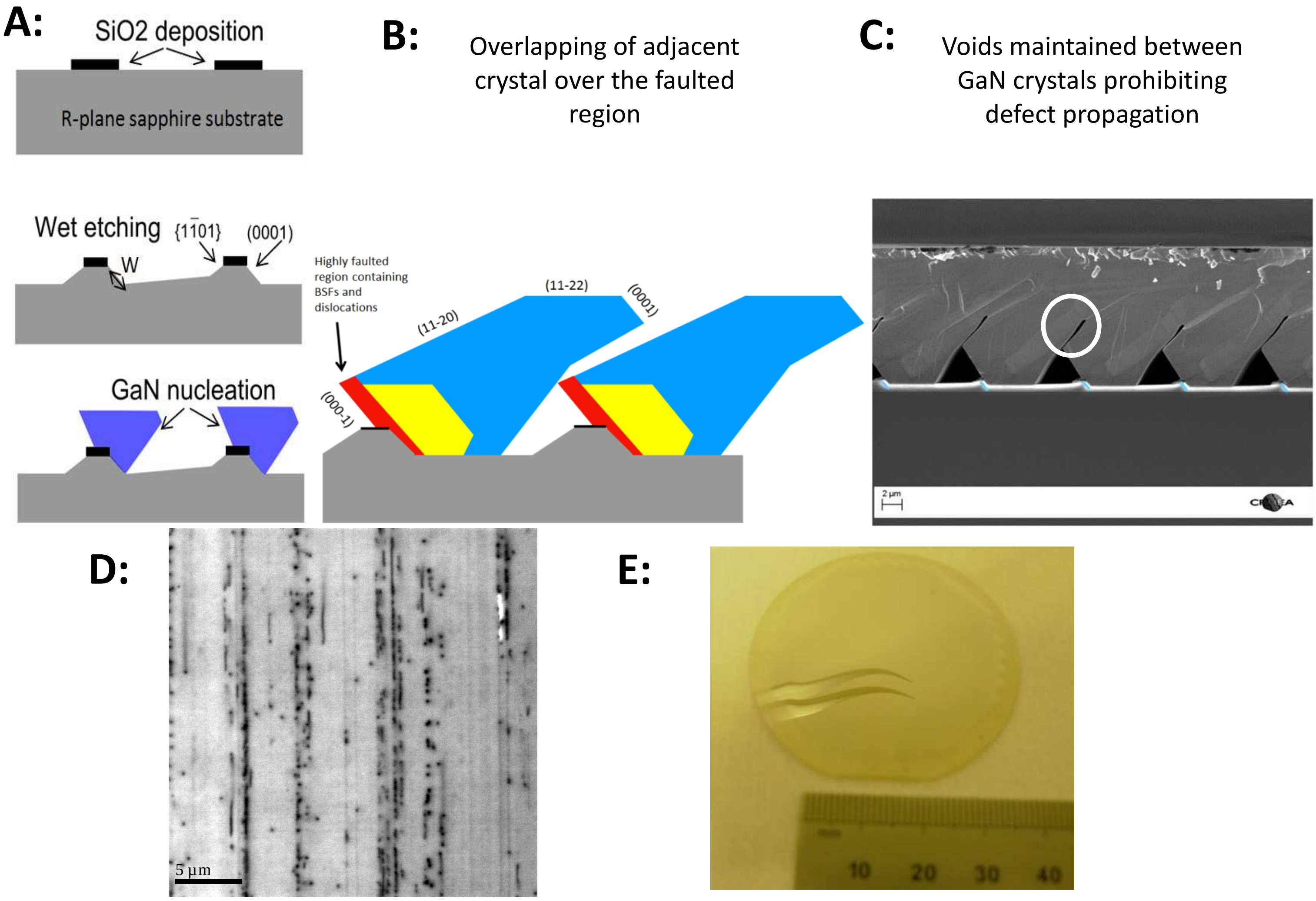
Semipolar gallium nitride (GaN) has a potential interest in order to achieve heterostructures with drastically reduced spontaneous and piezoelectric polarizations compared to c-oriented GaN. Optical devices with a semipolar orientation demonstrate an improved efficiency due to the decrease of the quantum confined Stark effect.

The heteroepitaxial approach is a way to provide such material with large surfaces. However up to now semipolar GaN layers usually suffer from the presence of important defects densities such as basal stacking faults (BSFs) and dislocations. These densities are a few orders of magnitude higher than for heteroepitaxially grown c-polar layers.

One of the most promising techniques to reduce the defect densities is the selective growth of GaN on a patterned sapphire substrate (PSS). Indeed it reduces the interface of nucleation between the sapphire and GaN.

High quality semipolar (11-22) GaN layers have been achieved by MOCVD on 2 -in. sapphire wafers by performing the selective area growth of GaN nitride from the inclined c-facets of a patterned sapphire substrate (PSS)[1].

Moreover advantage has been taken from the particular defects distribution in semipolar layers grown on PSS to remarkably improve the material quality by carefully choosing the growth conditions. Using a 3-step growth process which has been patented by CRHEA-CNRS, elongated voids between GaN crystals were formed and remained after coalescence blocking an important amount of defects. The resulting (11-22) GaN layers present a dislocation density of 5.1 x $10^7 cm^{-2}$ and a very low basal stacking fault density of less than 30 cm^{-1}, thereby reaching a semipolar material quality similar to conventional c-plane GaN on c-plane sapphire.



- **A**: Schematic representation of the patterning procedure and of the selective GaN growth (not on scale).
- **B**: Schematic cross section of crystal evolution during the overlapping process.
- **C**: SEM cross section after coalescence. A void is circled in white.
- **D**: Panchromatic cathodoluminescence in plane view (77K) assessing the defect density.
- **E**: Picture of a 2.in semipolar template.

[1] F. Tendille, P. De Mierry, P. Vennéguès, S. Chenot, and M. Teisseire, "Defect reduction method in (11-22) semipolar GaN grown on patterned sapphire substrate by MOCVD: Toward heteroepitaxial semipolar GaN free of basal stacking faults," *J. Cryst. Growth*, vol. 404, pp. 177–183, Oct. 2014.
DOI: 10.1016/j.jcrysgro.2014.07.020