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InGaN emitters grown on locally miscut substrates

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Fabrication of local change of the substrate miscut

The local change of bulk GaN substrate miscut (misorientation) is achieved thanks to the multilevel photolithography process and consecutive dry etching of the sample [1].

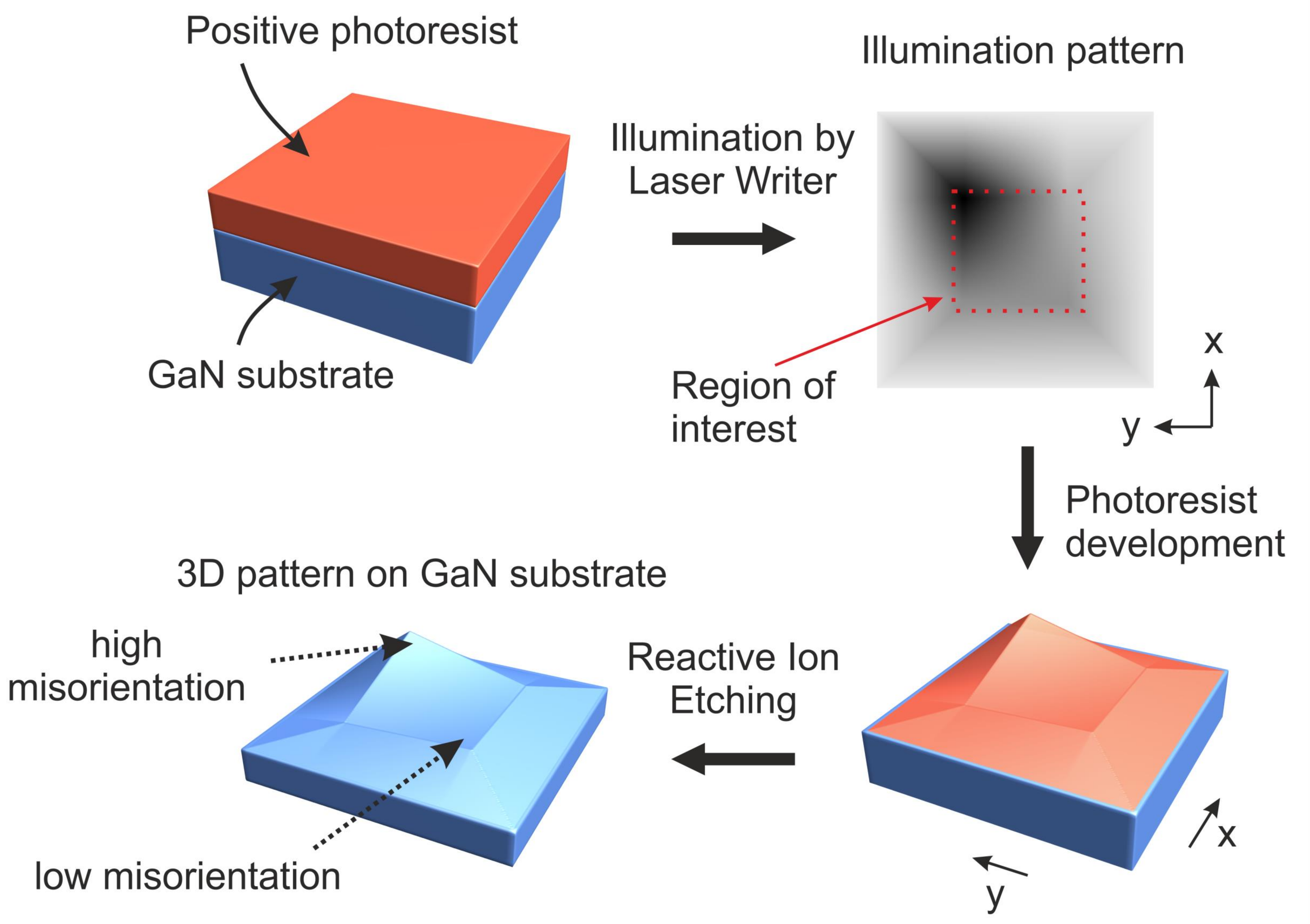

Fig. 1. Scheme of the fabrication process of a substrate pattern leading to a profile of local misorientation angle.

SLDs with broadened emission spectra

Our approach allows to broaden the emission spectra of nitride superluminescent diodes by creating a profile of indium content along the device waveguide [2], Fig. 4. This makes them better suited for advanced applications such as optical coherence tomography or fibre optical gyroscopes.

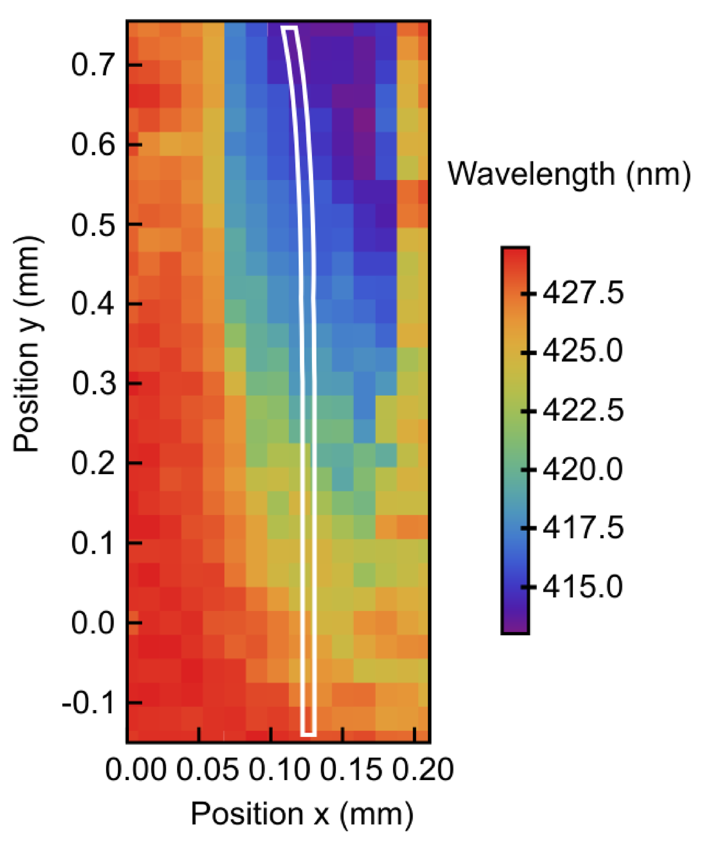

Fig. 4. Map of local emission wavelength in the area of an SLD stripe.

Best results are obtained when using a step-like profile of local misorientation that leads to the appearance of a double-peak spectral shape, Fig. 5.

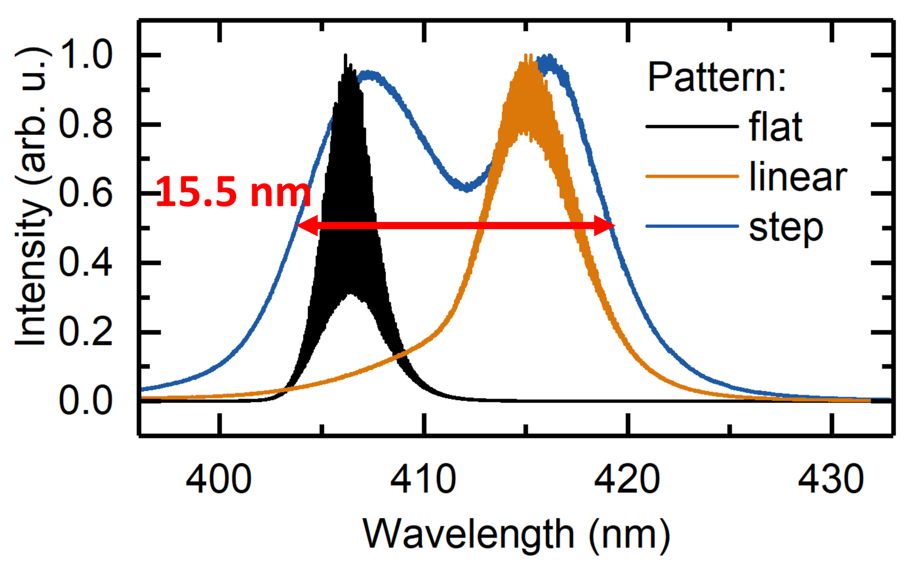

Fig. 5. Scheme of the fabrication process of a substrate pattern leading to a profile of local misorientation angle.

Summary

- It is possible to create a change in the local miscut of a bulk GaN substrate by the use of multilevel photolithography and dry etching.
- The change of local misorientation angle leads to new functionalities:
  - Local change of In content in the InGaN QWs by even 8%,
  - Improvement of the quality of the InGaN layers with high In content,
  - Superluminescent diodes with broadened emission spectra,
  - Low-loss monolithically integrated optical waveguides.
  - Possibility of fabricating multiwavelength emitter arrays within one chip

Modification of active region by miscut

This work was done in collaboration with:

- **R. Ishii, M. Funato, Y. Kawakami** from Department of Electronic Science and Engineering, Kyoto University
- **A. Sakaki, M. Tano** from Nichia Corporation

The modification of local substrate miscut can be successfully used to modify the amount of indium that is incorporated into InGaN layers during the MOCVD growth [3]. Higher substrate miscut corresponds to lower In content.

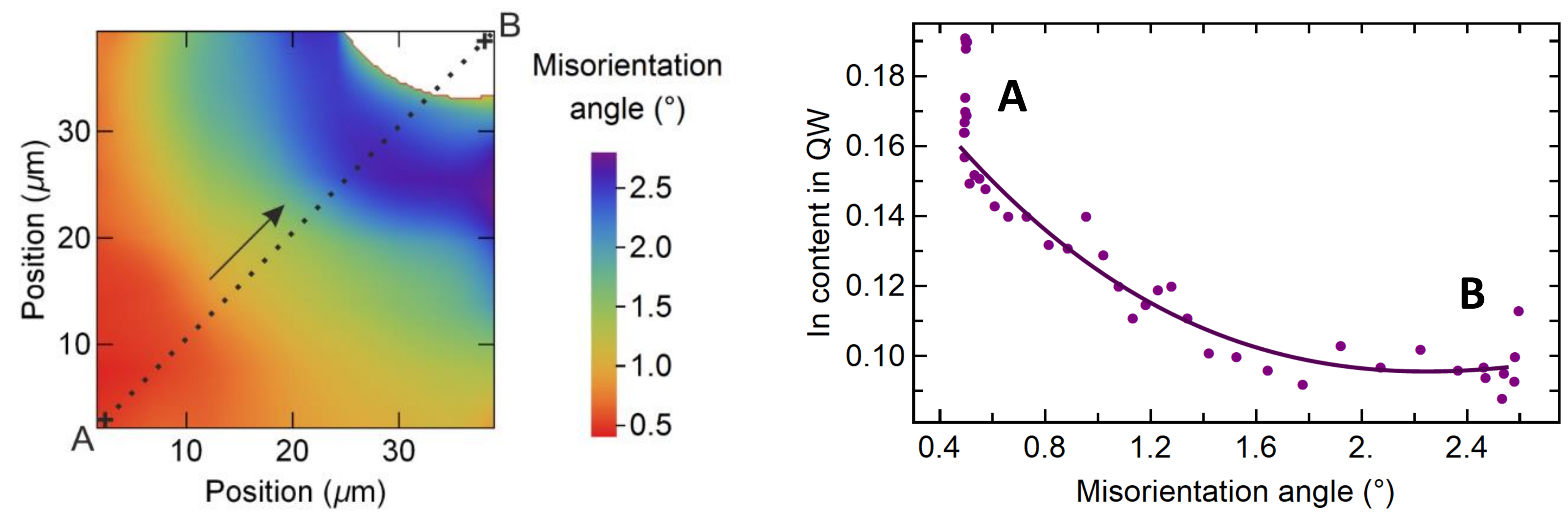

Fig. 2. (a) A map of local miscut and corresponding relations between the miscut and the amount of indium in the InGaN quantum well.

The increase of miscut is also beneficial in case of the growth of quantum wells with higher In content [4], Fig. 3.

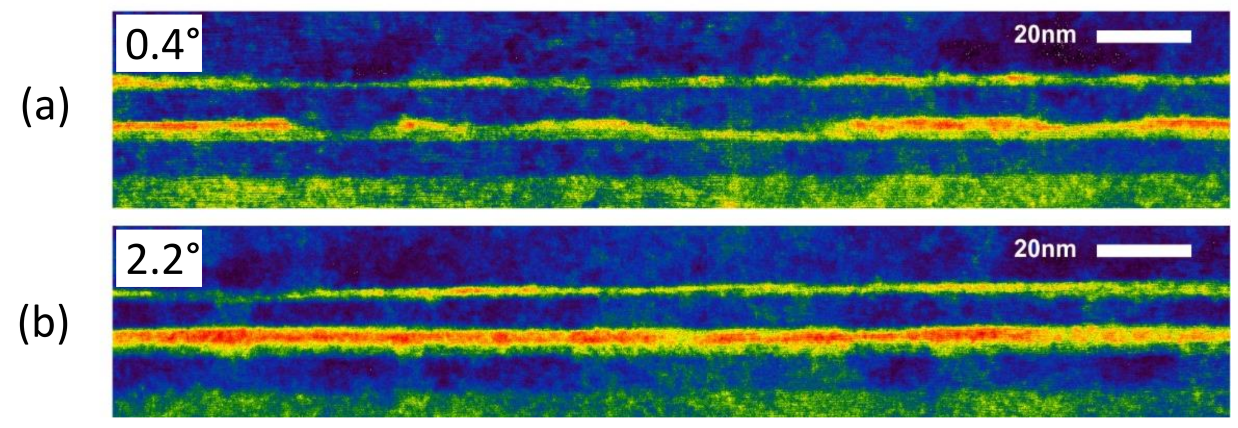

Fig. 3. Comparison of the HAADF TEM images of the InGaN quantum wells from the same sample but grown in regions differing by local substrate miscut.

Low-loss (In,Al)GaN waveguides

The change of local miscut can be also used to locally shift the absorption edge of the active region and by that create monolithically integrated waveguide structures [5].

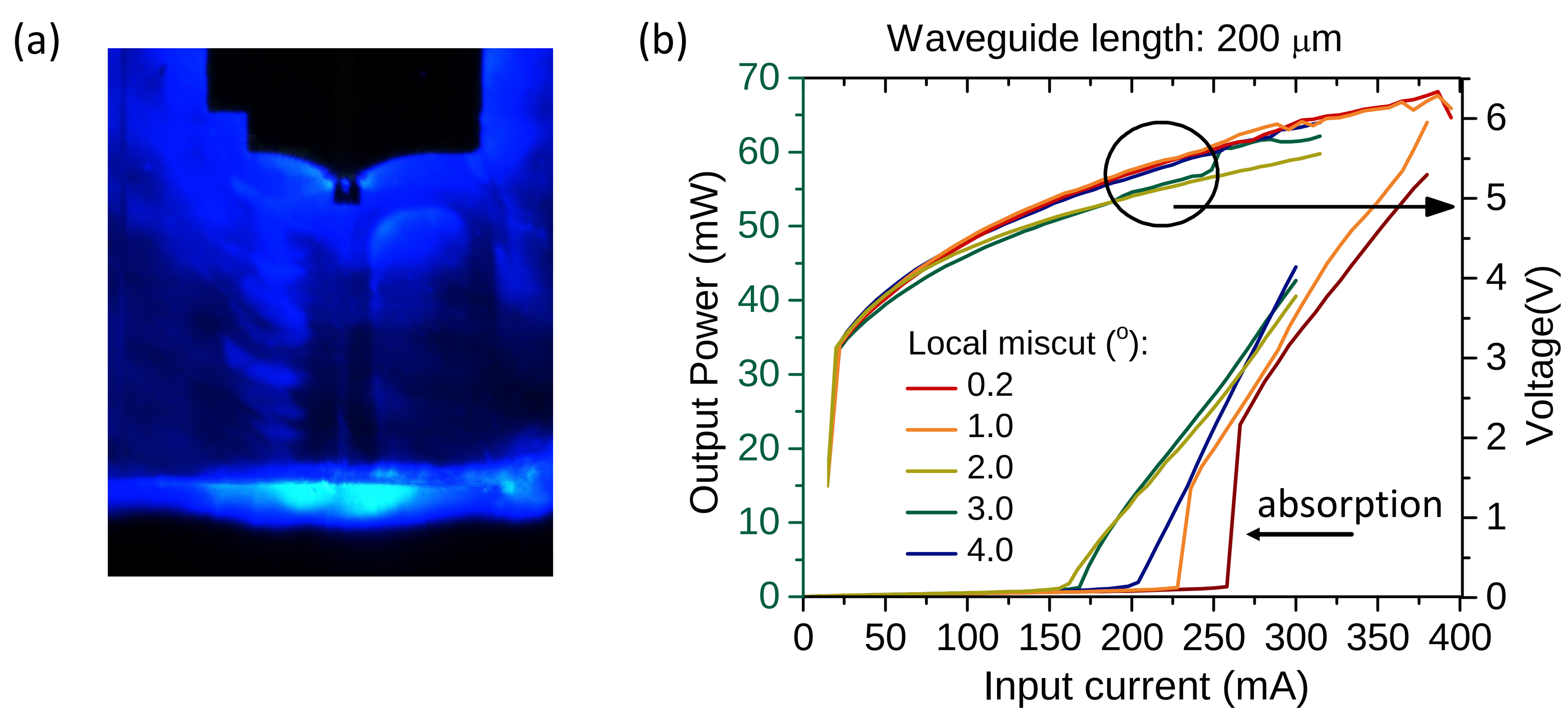

Fig. 6. Demonstration of the monolithic waveguides: (a) microscope picture of the working device and (b) reduction of absorption in the device with increasing miscut.

References

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