



**HAL**  
open science

## Photoluminescence of 2D-vertical In-rich APBs embedded in InGaP/SiGe/Si

Lipin Chen, Oliver Skibitzki, Yoan Léger, Christophe Levallois, Rozenn Piron,  
Tony Rohel, Julie Stervinou, Antoine Létoublon, Thomas Schroeder, Charles  
Cornet

► **To cite this version:**

Lipin Chen, Oliver Skibitzki, Yoan Léger, Christophe Levallois, Rozenn Piron, et al.. Photoluminescence of 2D-vertical In-rich APBs embedded in InGaP/SiGe/Si. 20th International Conference on Molecular-Beam Epitaxy (ICMBE 2018), Sep 2018, Shanghai, China. 2018. hal-01909074v2

**HAL Id: hal-01909074**

**<https://hal.science/hal-01909074v2>**

Submitted on 19 Jun 2020

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



# Photoluminescence of 2D-vertical In-rich APBs embedded in InGaP/SiGe/Si

L. Chen<sup>1</sup>, O. Skibitzki<sup>2</sup>, Y. Léger<sup>1</sup>, C. Levallois<sup>1</sup>, R. Piron<sup>1</sup>, T. Rohel<sup>1</sup>, J. Stervinou<sup>1</sup>, A. Letoublon<sup>1</sup>, T. Schroeder<sup>2</sup> and C. Cornet<sup>1</sup>

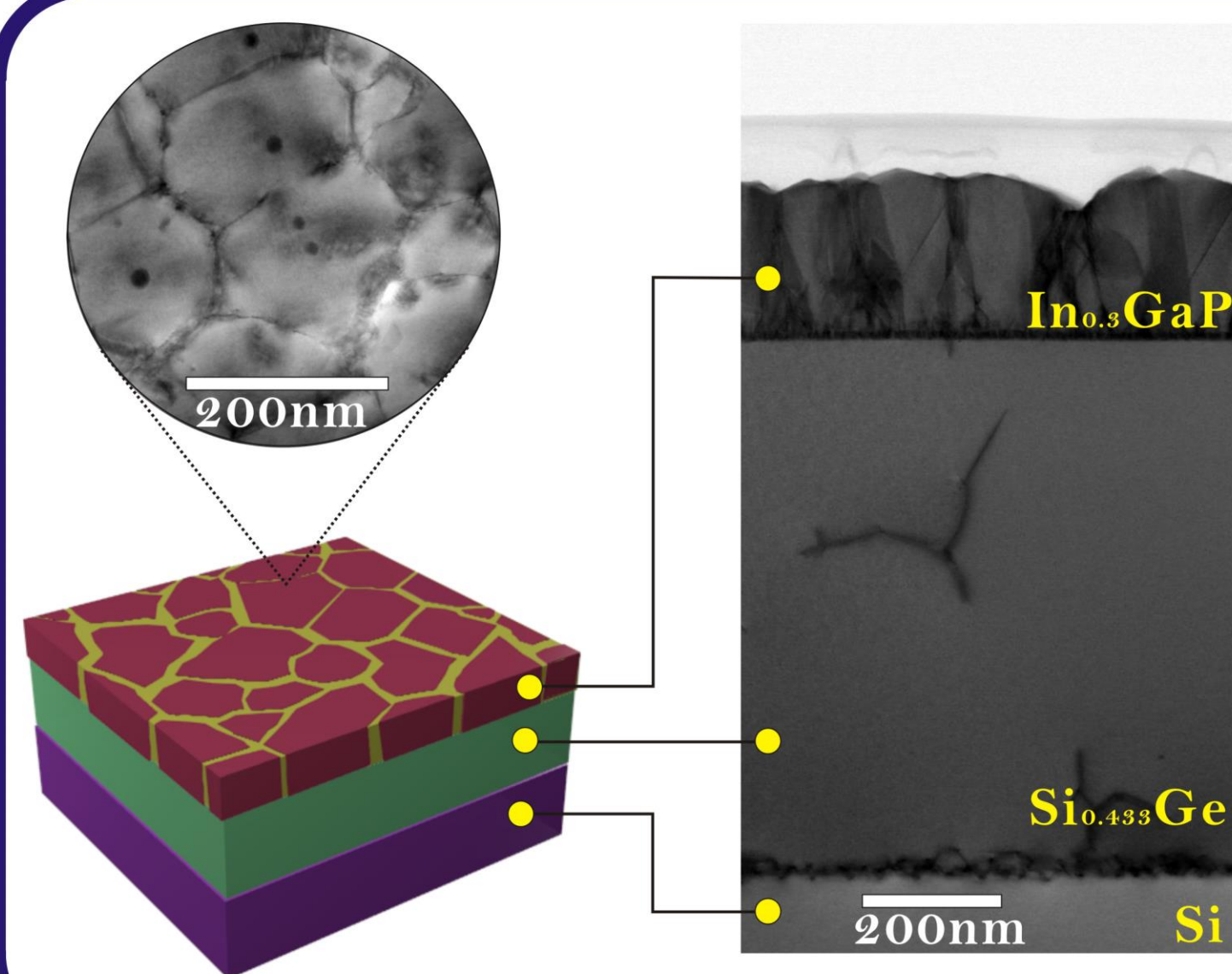
<sup>1</sup> Univ Rennes, INSA Rennes, CNRS, Institut FOTON-UMR 6082, F-35000 Rennes, France

<sup>2</sup> IHP, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany

## Introduction

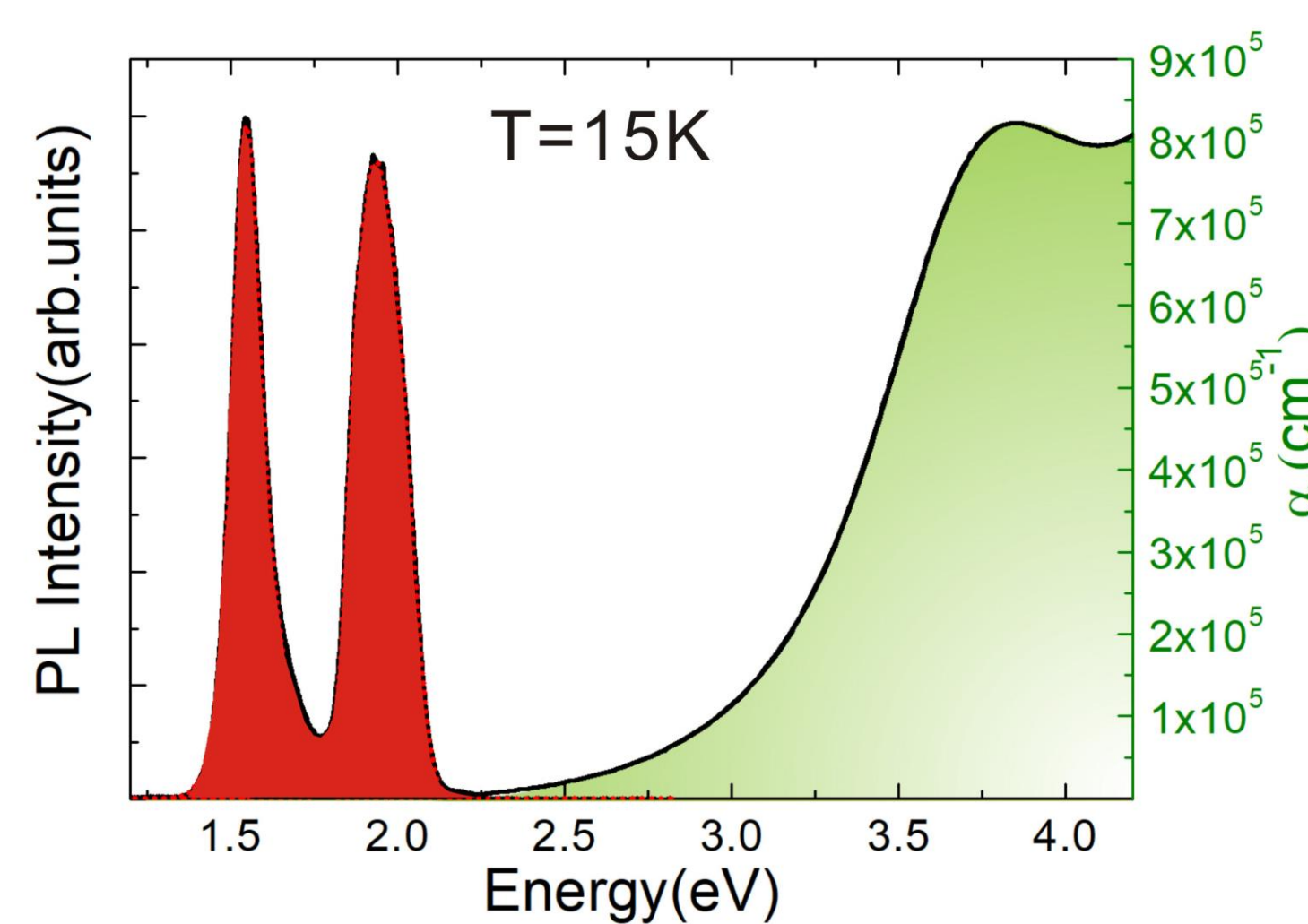
Heterogeneous epitaxy of III-V compounds with superior optical properties onto Si substrate very close to the III-V/Si hetero-interface becomes major concern for Si photonics. Antiphase boundaries (APB) are generated during heteroepitaxy, have always been considered as detrimental defects for optical devices. However, in this work we provided a new insight into the APBs which are involved in an efficient luminescence process.

## TEM micrographs



- InGaP active layer contains many antiphase boundaries (APBs)
- Some quantum dots (QDs) observed on the surface

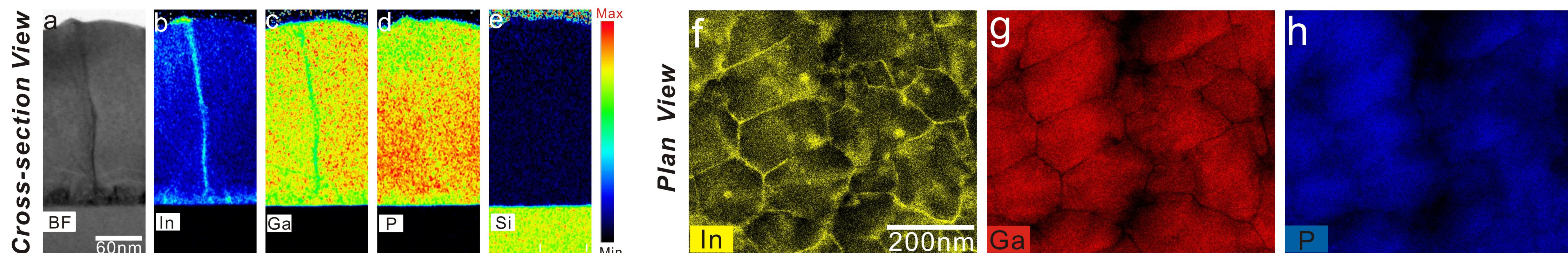
## PL and optical absorption spectra



- Two transitions detected on the PL spectrum
- The onset of the absorption is around the high energy peak i.e. it likely related to band to band recombination

## EDX elemental mapping

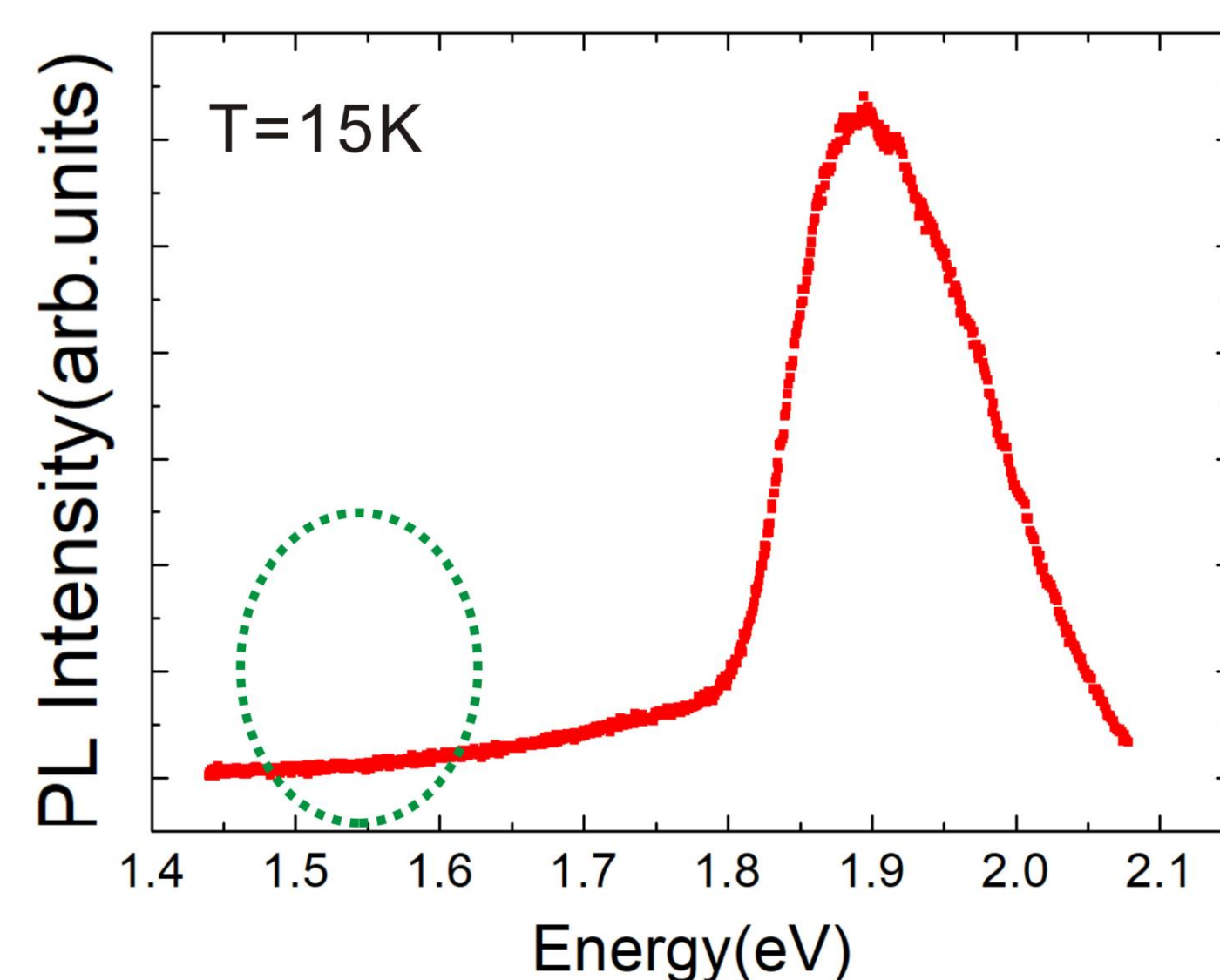
- Two kinds of nanostructures: pure InP surface QDs and In-rich APBs



## Sample after CMP

SEM images of as-grown sample and sample after chemical mechanical polishing (CMP)

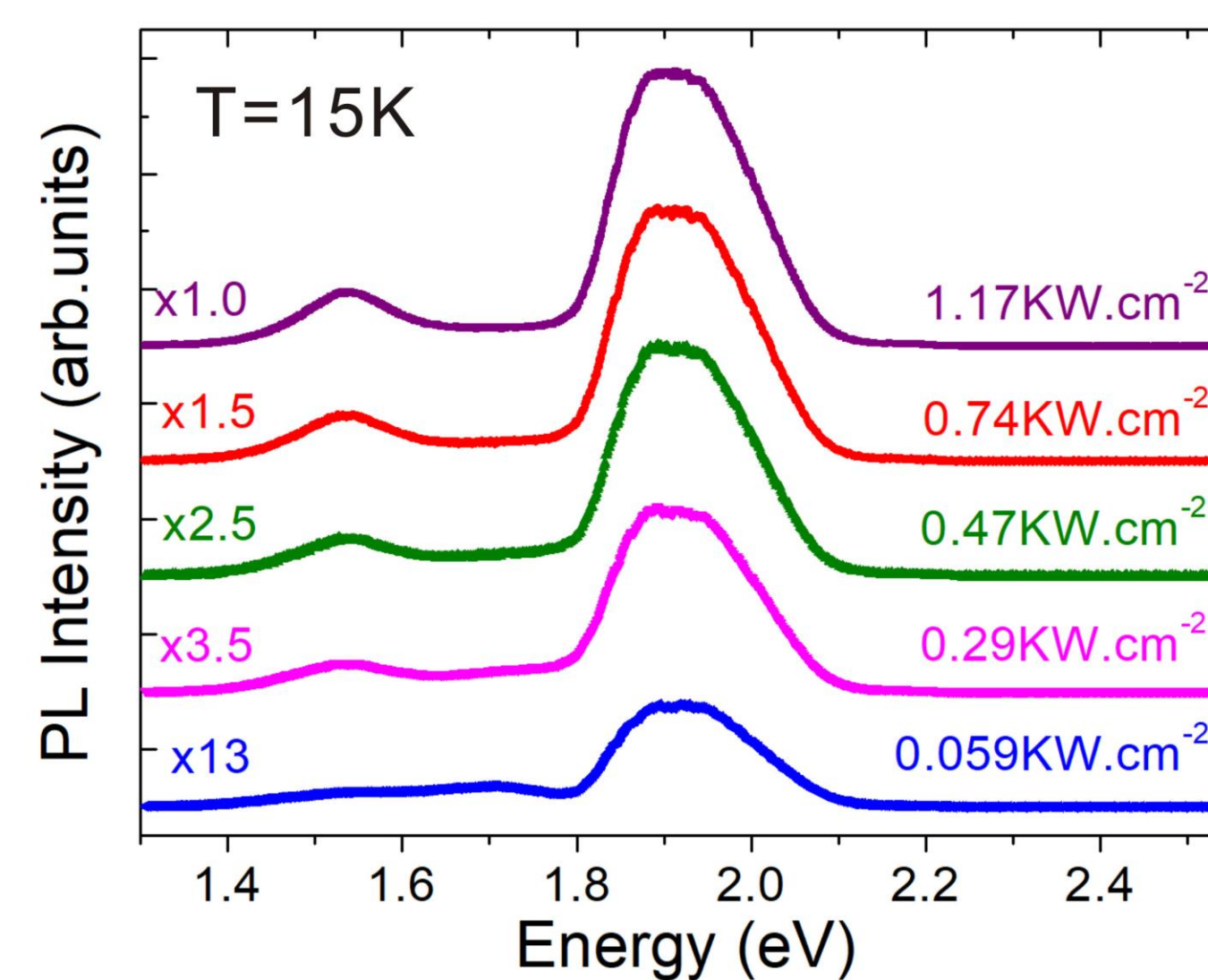
- Surface QDs are almost removed after CMP



### PL after CMP process

- Low energy peak disappears
- ➔ Low energy peak comes from the surface InP QDs.

## Power-dependent PL

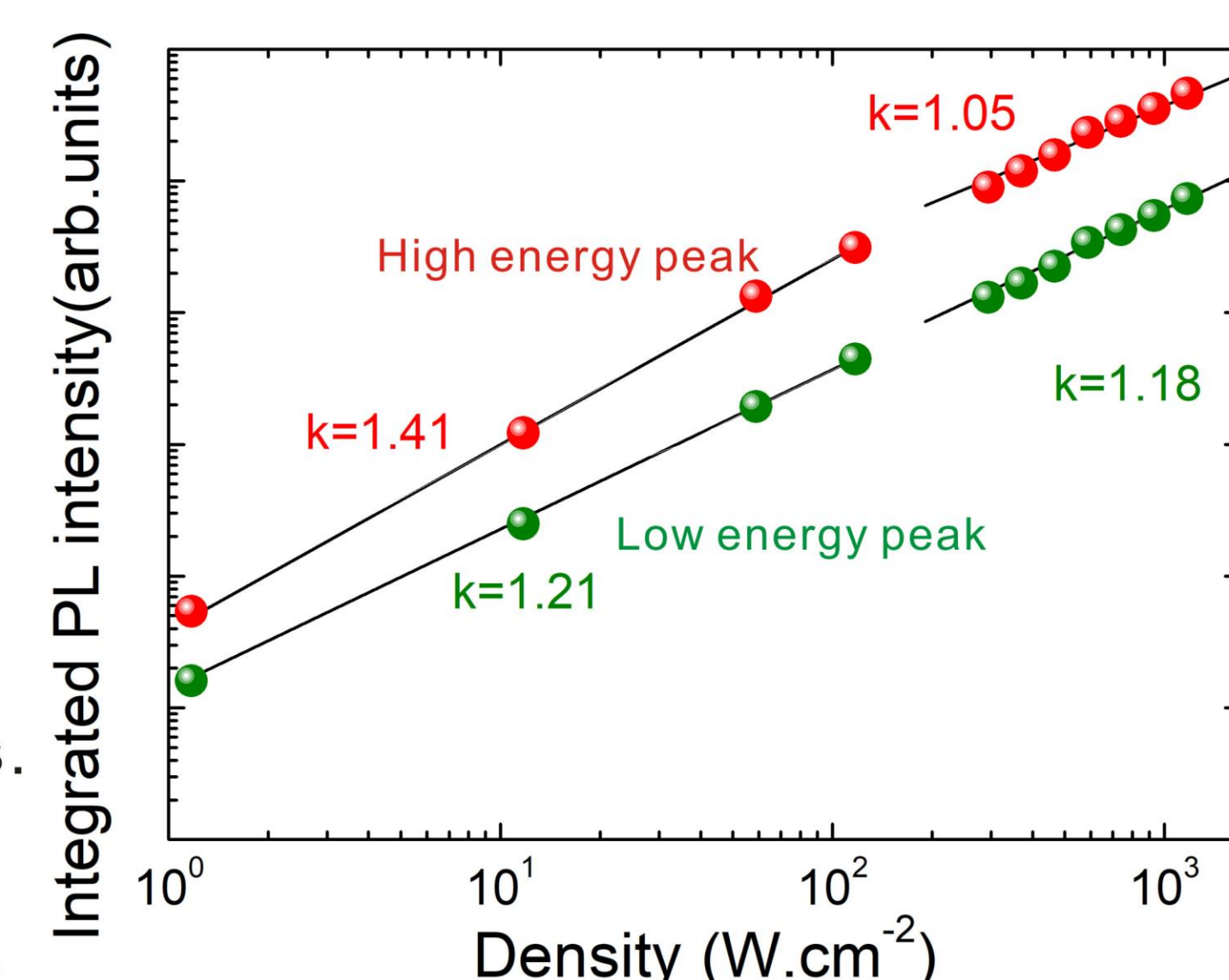


### Integrated PL intensity versus power density

- High energy peak shows superlinear to linear power-dependent behaviour
- ➔ Typical feature of excitation process via exciton bounded to neutral acceptors or donors.

He, H. et al. Nature Communications, 7(2016).  
Schmidt, T.K. et al. Physical Review B, 45(1992).

### Steady-state PL with saturated InP QDs



## Physical mechanism proposed for the high energy PL peak

- In APB spacing, many acceptor-like states shown due to III-III bonds in the band gap
- Excitons bounded to neutral APBs

Tea, E. et al. Journal of Applied Physics, 115(2014).

## Conclusions

- ➔ Preferential incorporation of In atoms on APBs is evidenced.
- ➔ Low energy peak is proved to come from the surface InP QDs.
- ➔ High energy peak results from localized excitons bounded around the neutralized In-rich APBs.