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

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

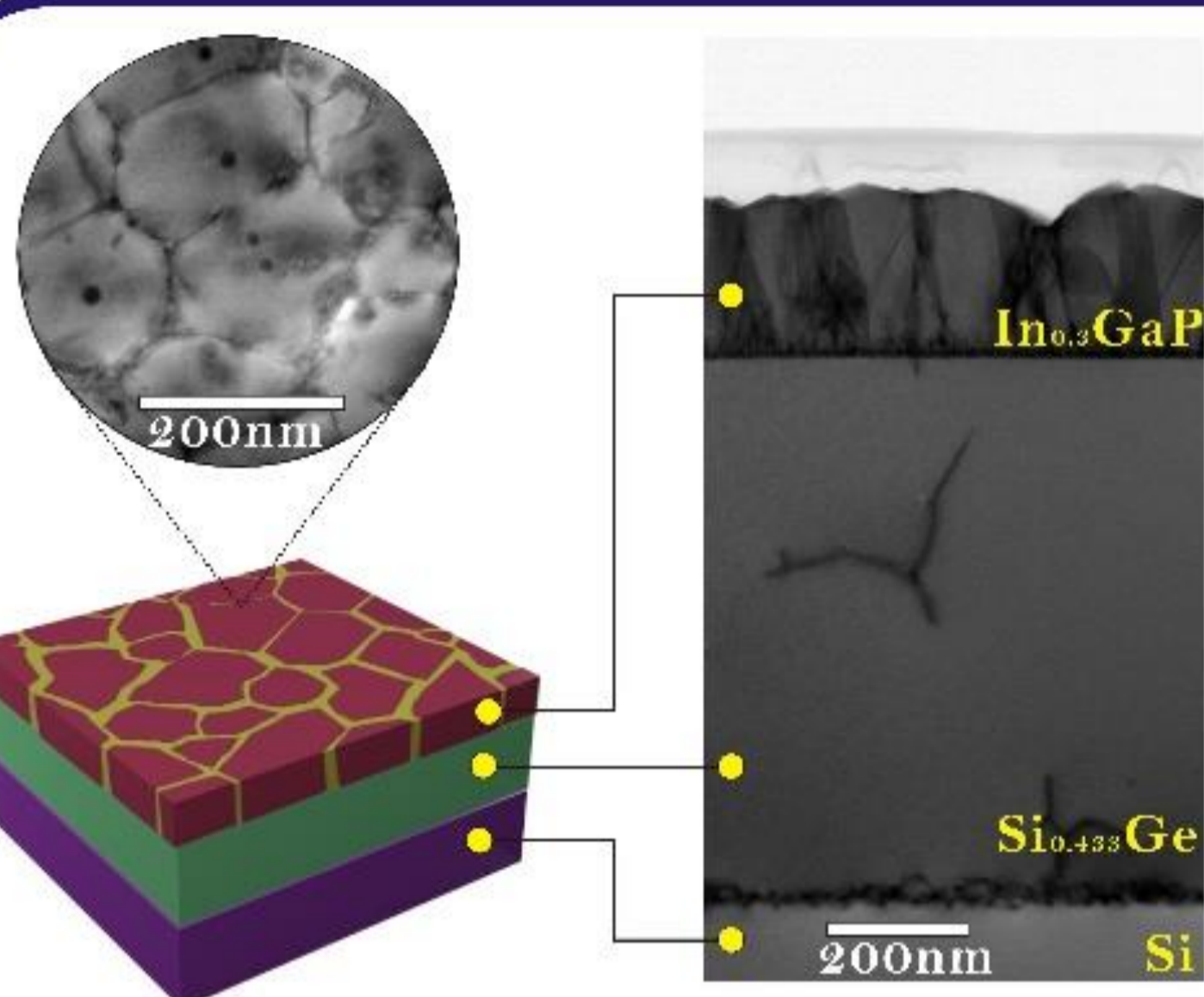
L. Chen<sup>1</sup>, O. Skibitzki<sup>2</sup>, Y. Léger<sup>1</sup>, C. Levallois<sup>1</sup>, R. Piron<sup>1</sup>, T. Rohel<sup>1</sup>, J. Stervinou<sup>1</sup>, A. Letoublon<sup>1</sup>, T. Schroeder<sup>2</sup> and C. Cornet<sup>1</sup>

<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

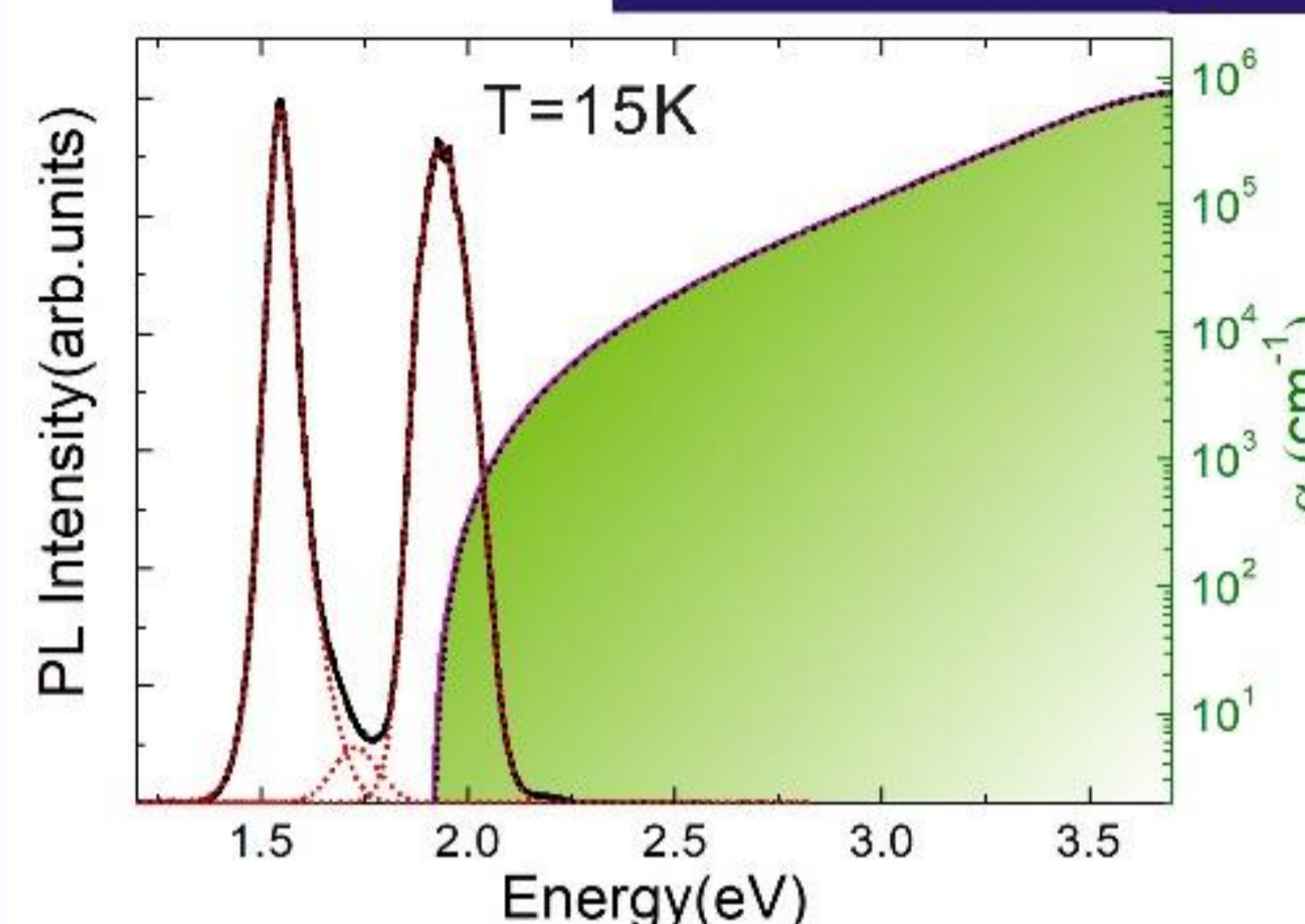
Heterogeneous epitaxy of III-V compounds with superior optical properties onto Si substrate very close to the III-V/Si hetero-interface becomes major concern for Si photonics. Antiphase boundaries (APB) are generated during heteroepitaxy, have always been considered as detrimental defects for optical 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

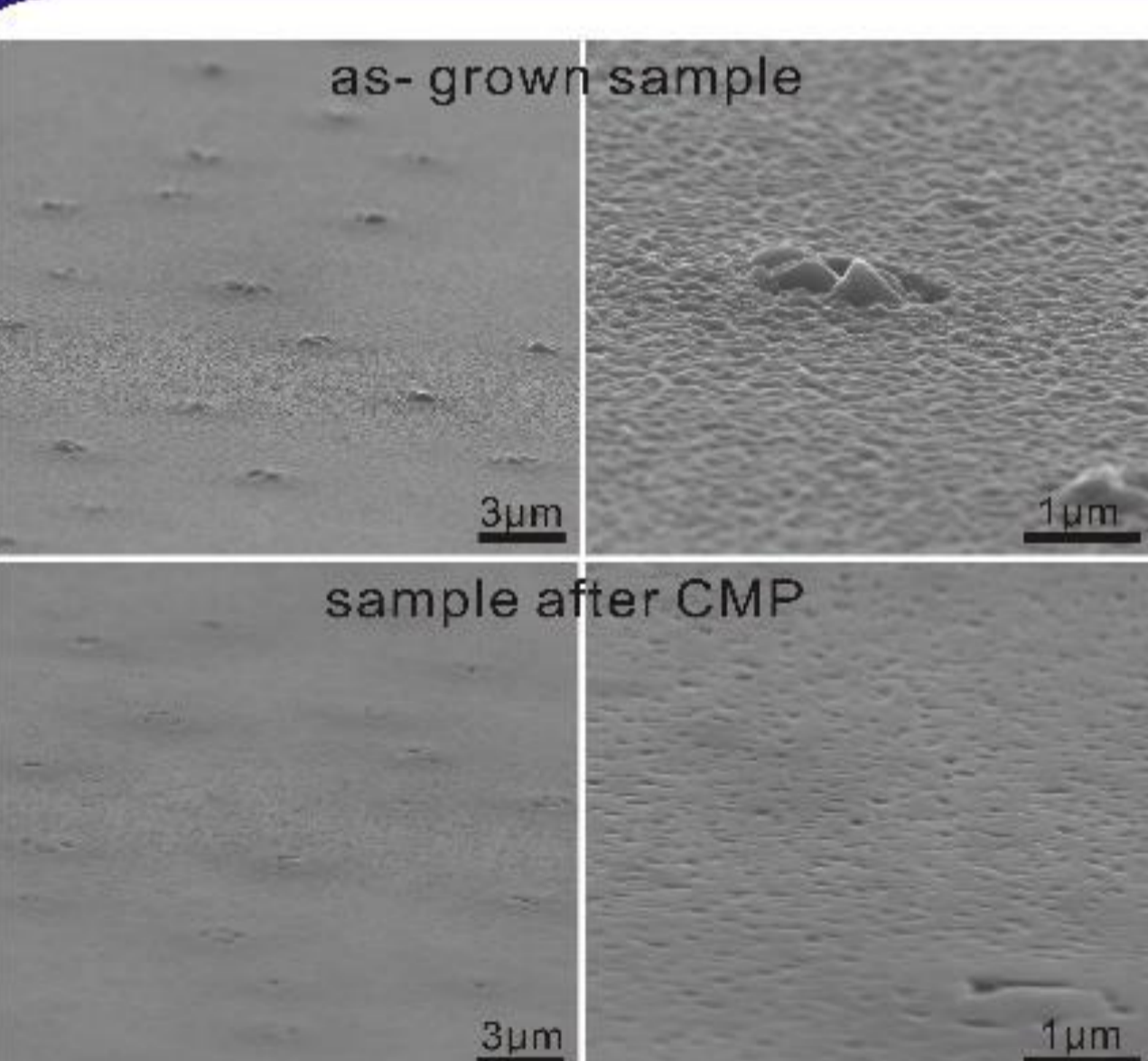
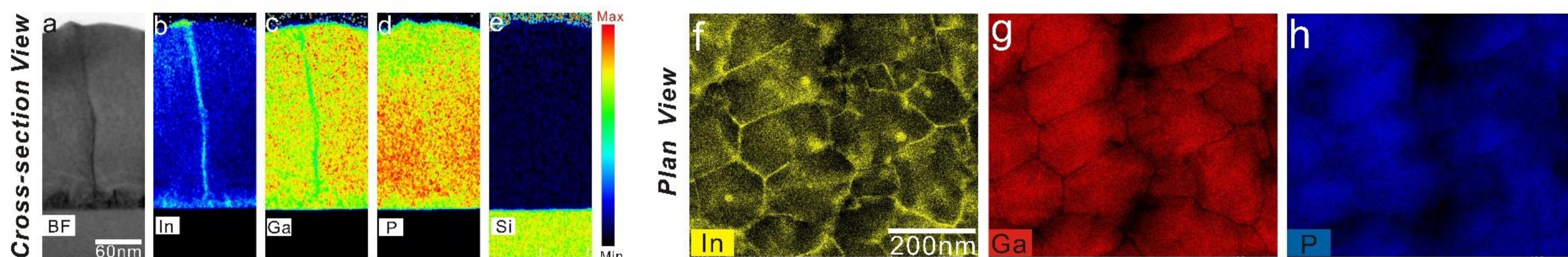
## PL and optical absorption spectra



- Two transitions detected on the PL spectrum
- High energy peak corresponds to the bandgap value, i.e. it likely related to band to band recombination

## EDX elemental mapping

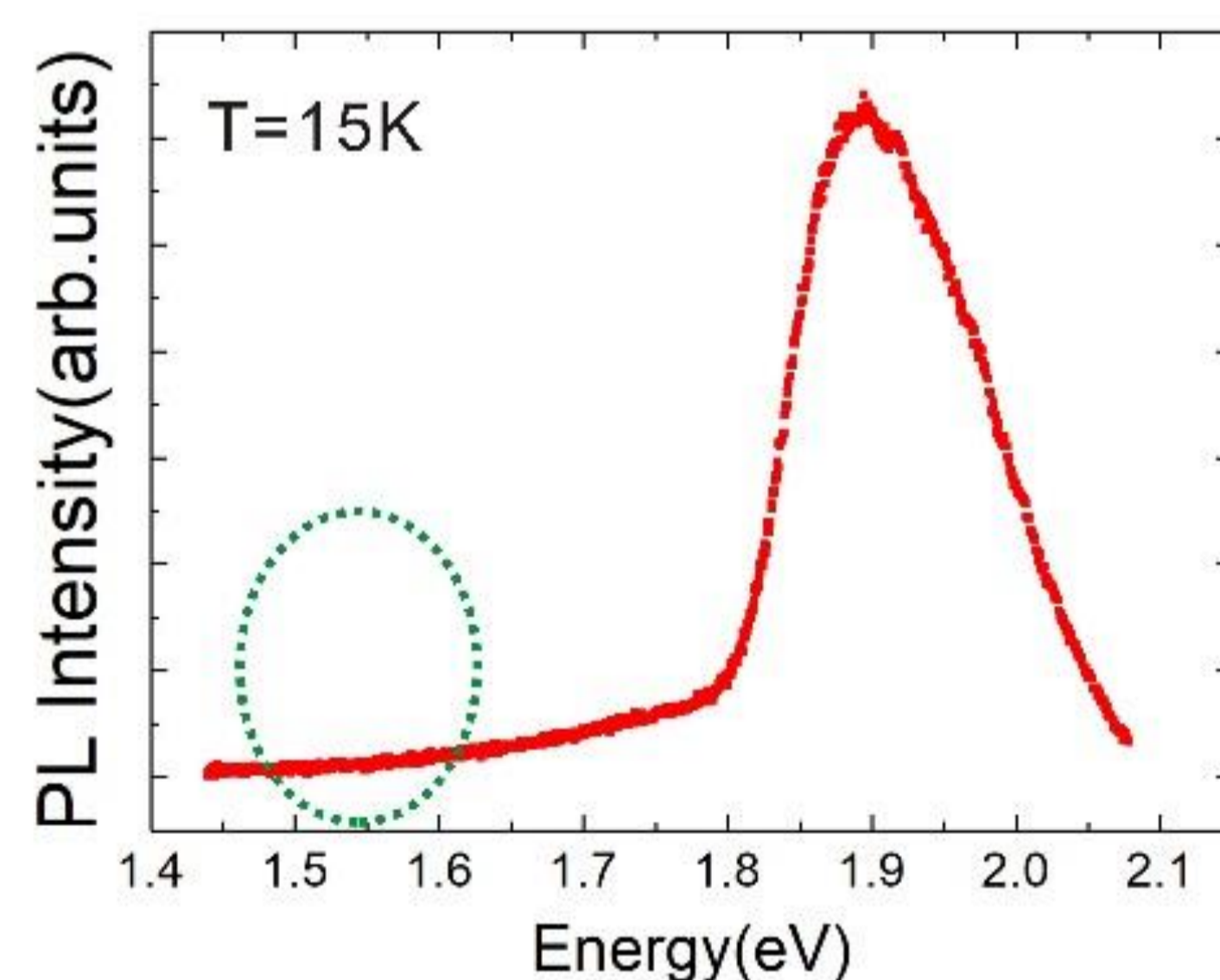
- Two kinds of nanostructures: pure InP surface QDs and In-rich APBs



## Sample after CMP

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

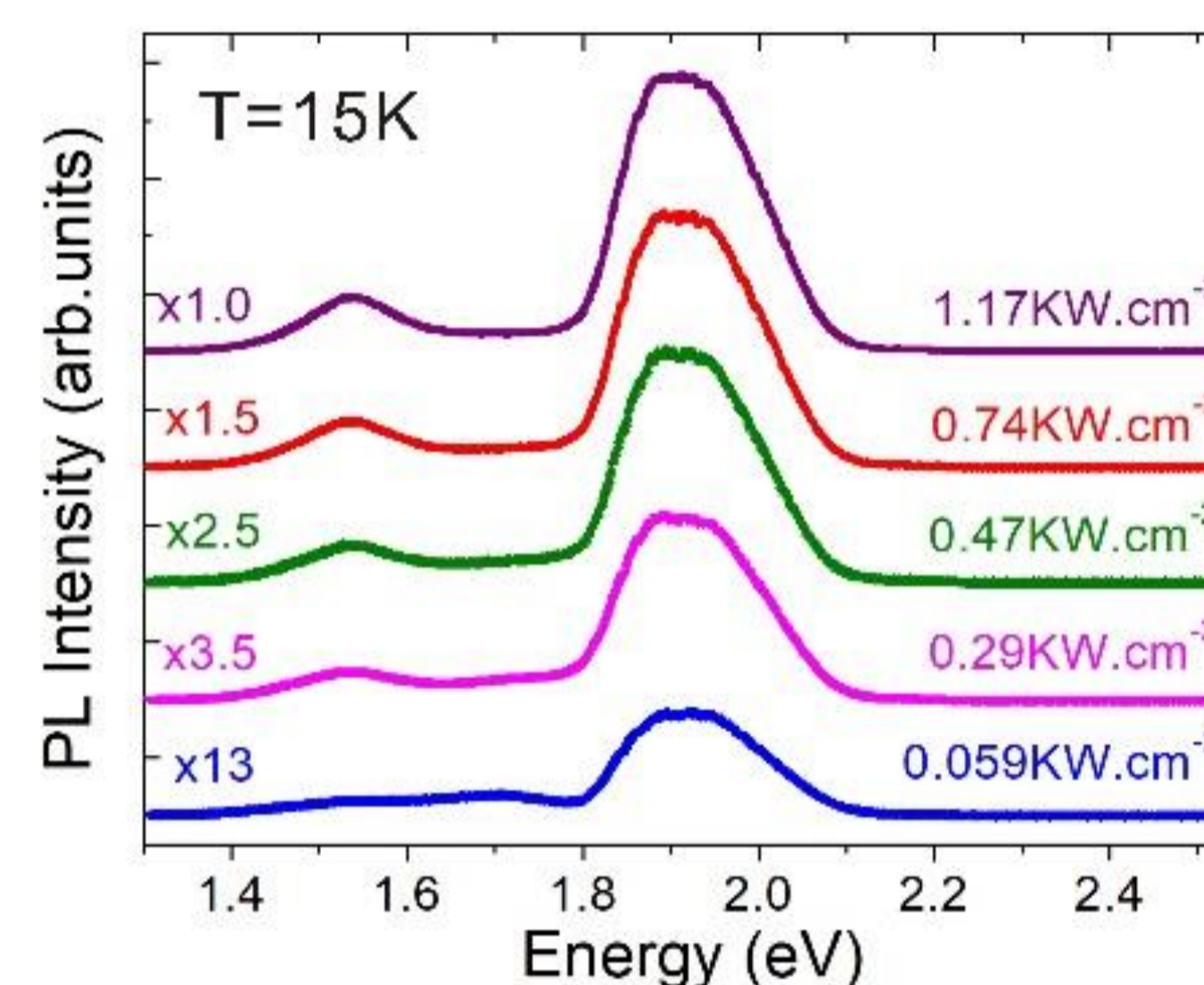
- Surface QDs are almost removed after CMP



### PL after CMP process

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

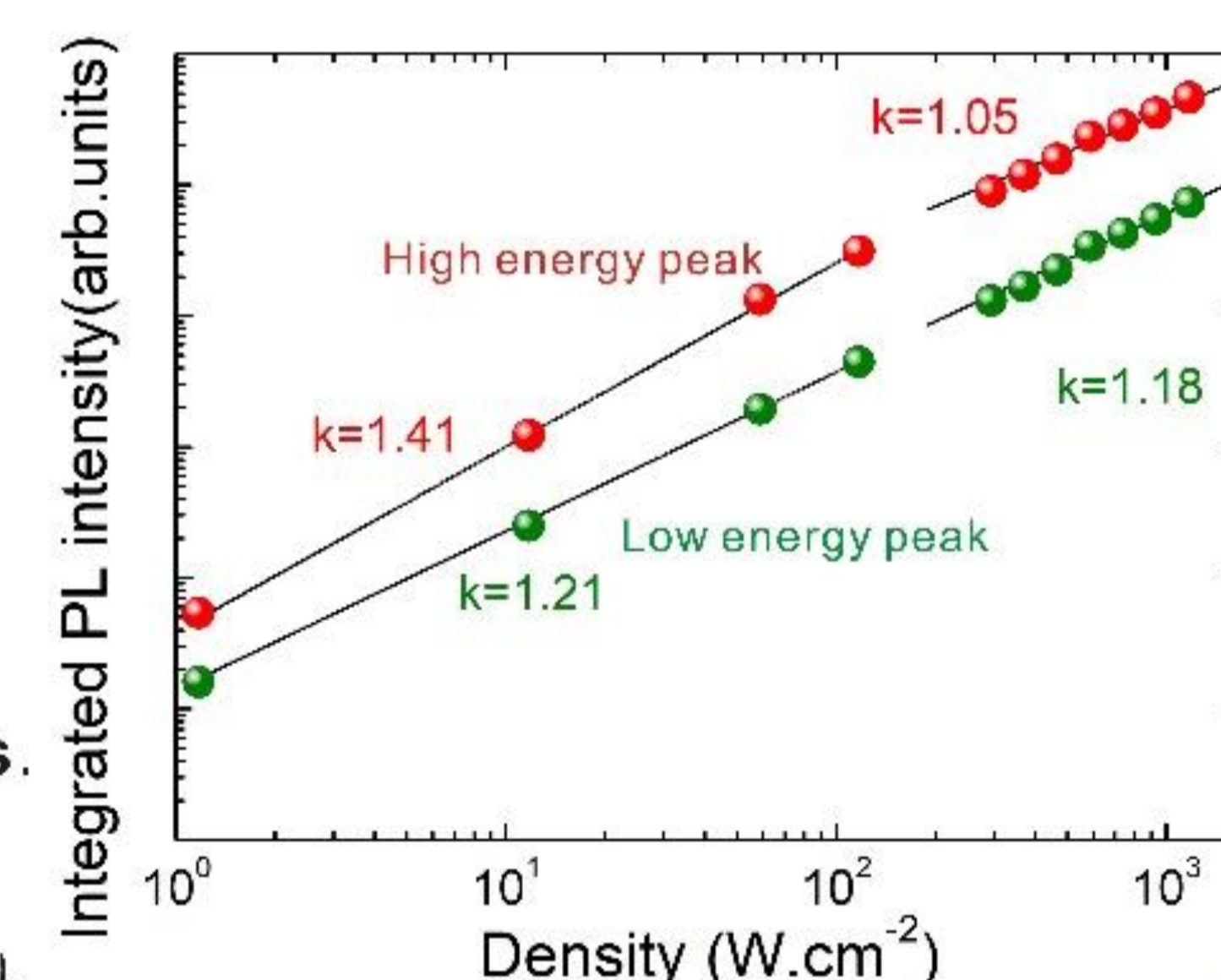
## Power-dependent PL



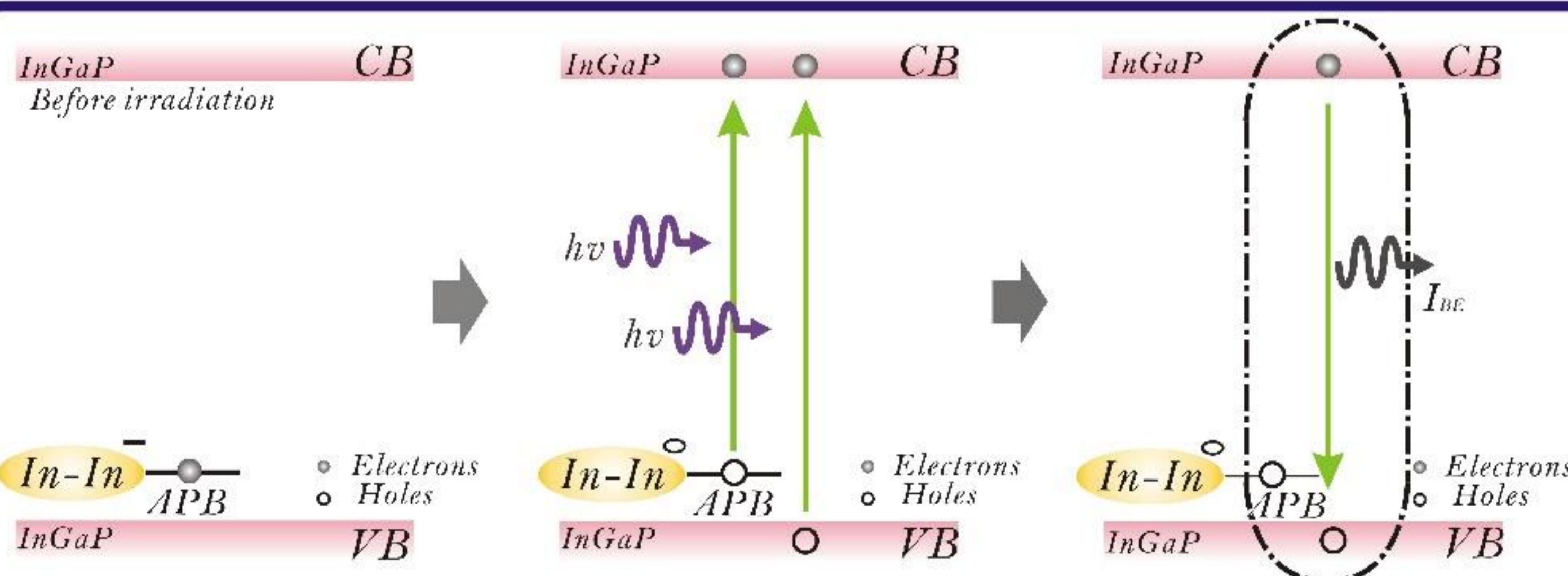
Steady-state PL with saturated InP QDs

### 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).



## 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.