

# Photoconductive Gain Mechanism in $\beta\text{-Ga}_2\text{O}_3$

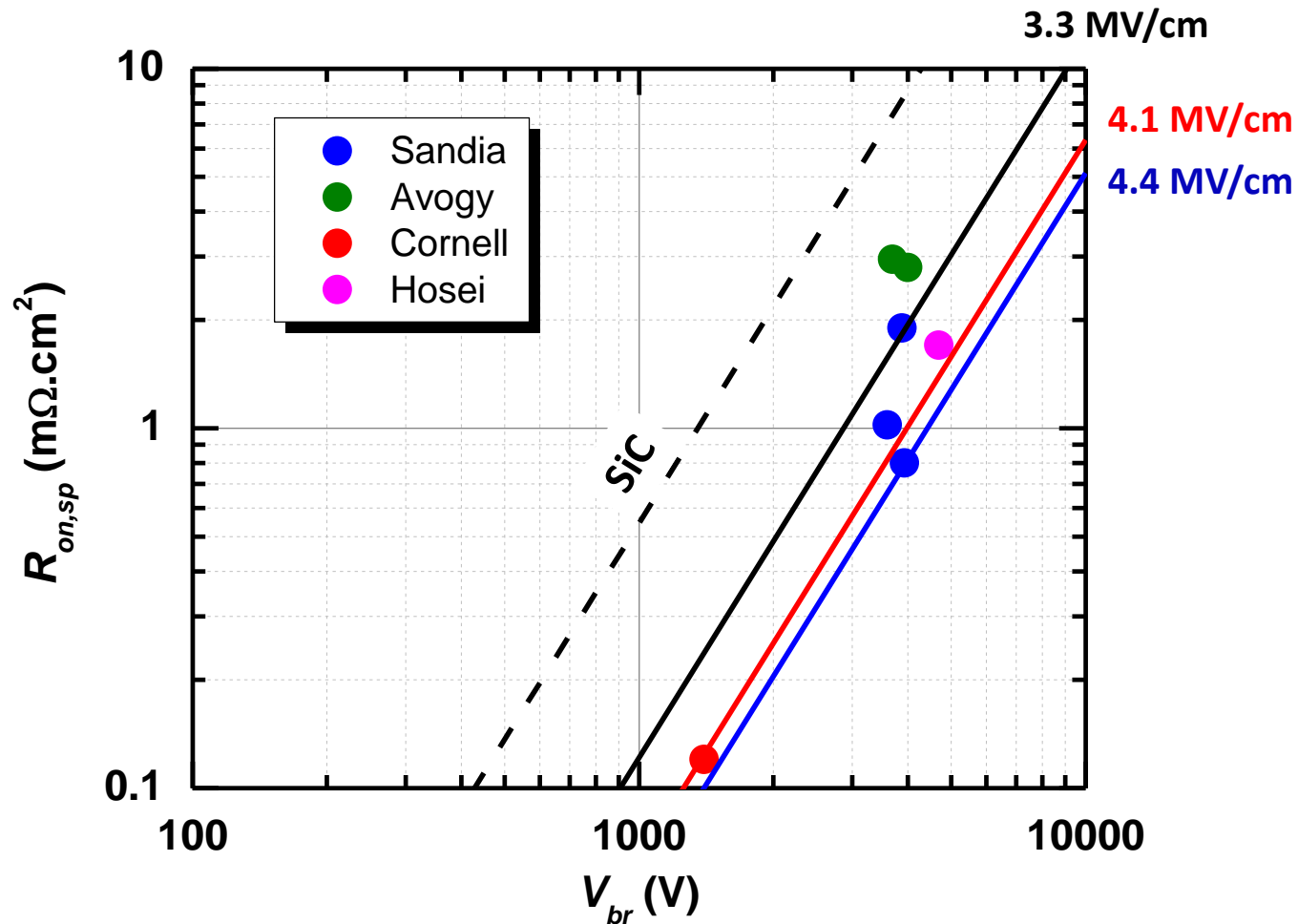
Andrew M. Armstrong, and Mary H. Crawford

Sandia National Laboratories  
Albuquerque, NM USA

Asanka Jayawardena, Ayayi Ahyi, and Sarit Dhar

Auburn University  
Auburn, GA USA

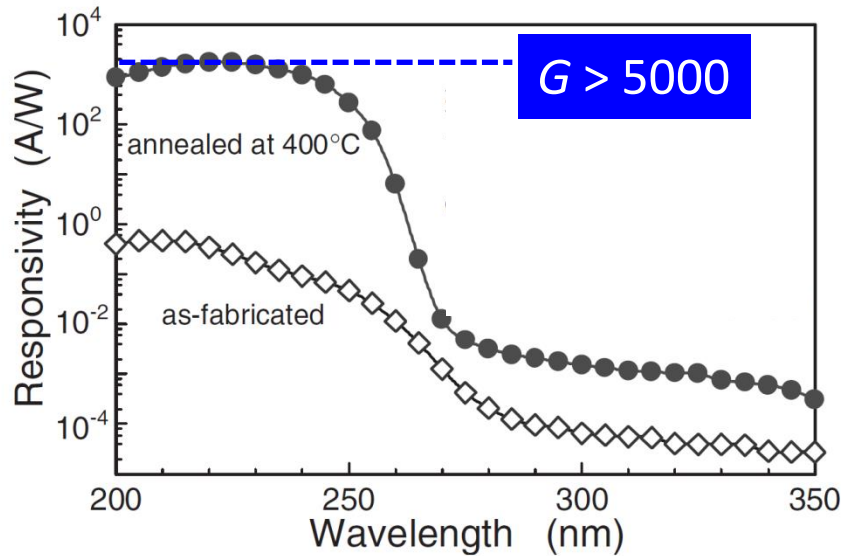
# Progress in GaN PN diodes



➤ Progress in GaN diodes proving critical electric field is much larger than expected

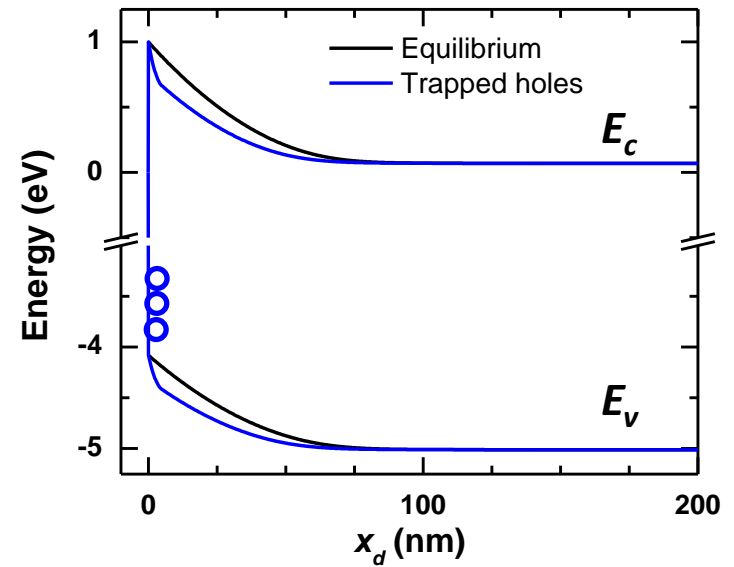
# Strong photo-gain for solar-blind $\beta\text{-Ga}_2\text{O}_3$ Schottky diodes

## Schottky diode spectral response



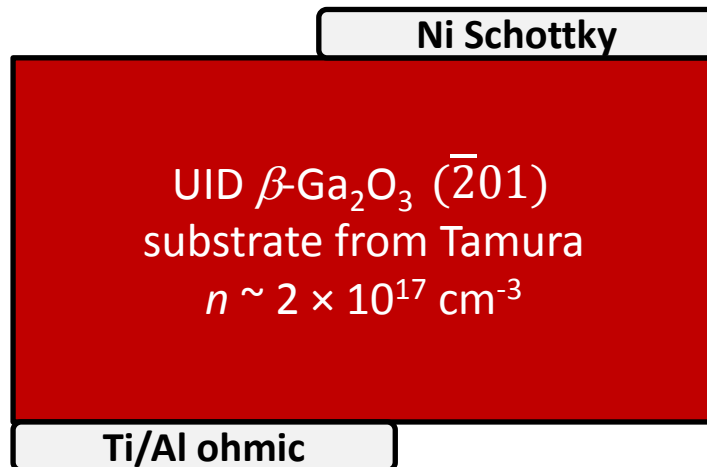
\*R. Suzuki et al., APL 94 222102 (2009).

## Schottky-trapped holes unlikely

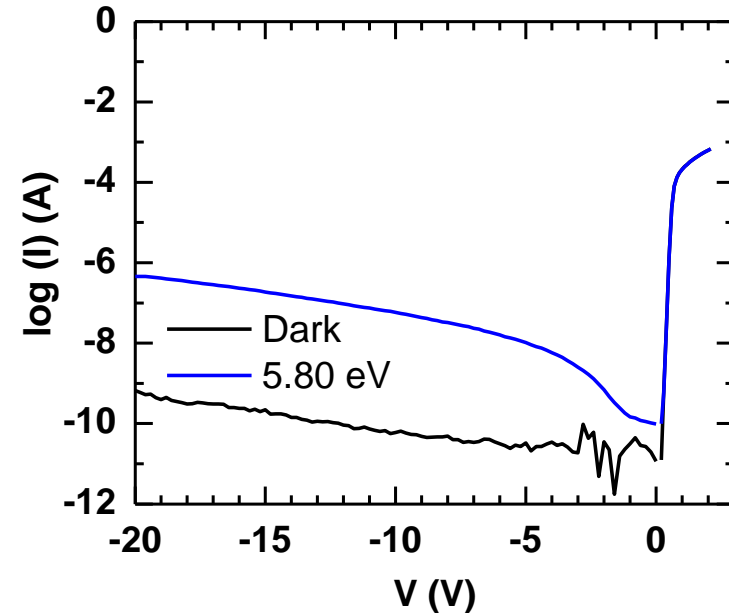


- Unusual for Schottky diodes to exhibit any photoconductive gain
- Popular theory is hole trapping at Schottky metal\*

# $\beta$ -Ga<sub>2</sub>O<sub>3</sub> material and Schottky device



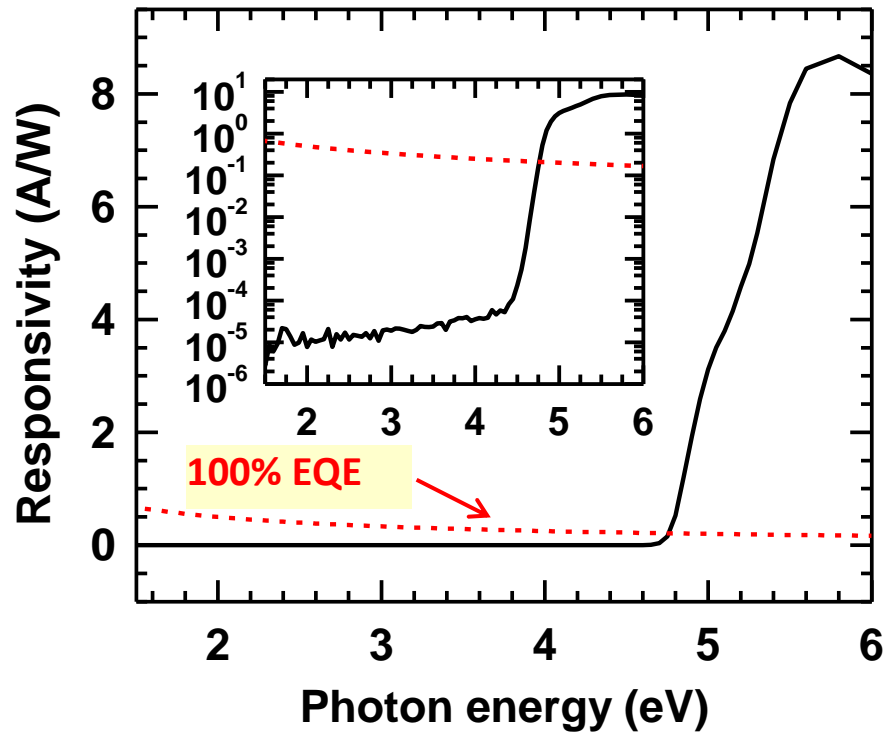
## Diode photoconductivity



- No post-growth treatment other than Piranha clean
- Strong photoconductive response under reverse bias

# Strong photoconductive gain

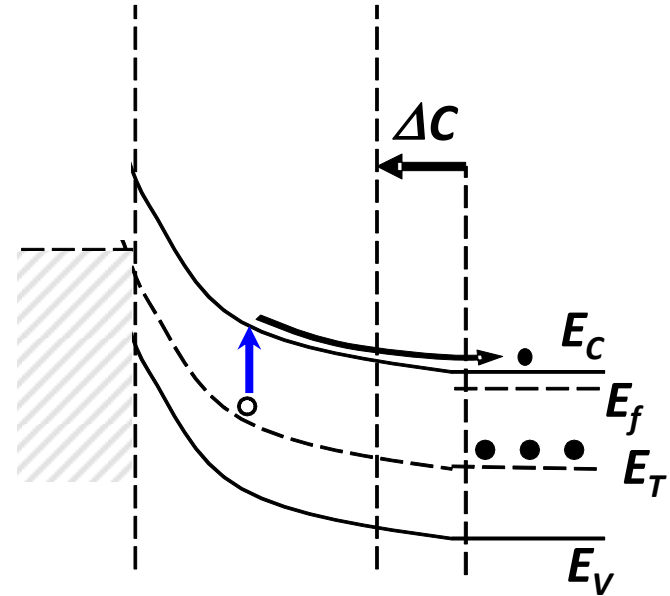
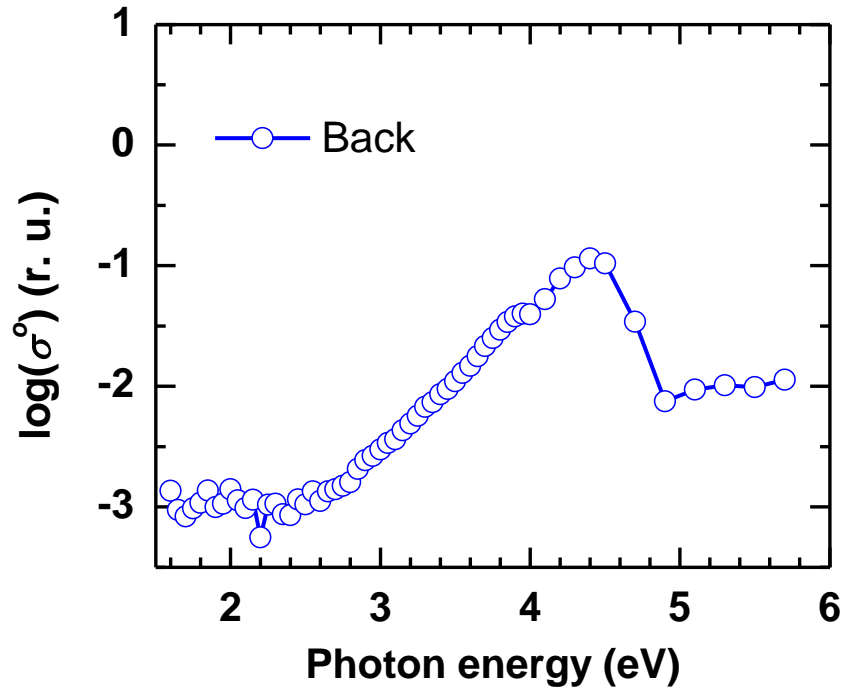
## Spectral Photoresponse



- Peak optical gain > 50x
- Solar rejection-ratio > 10<sup>5</sup>

# Defects and hole localization

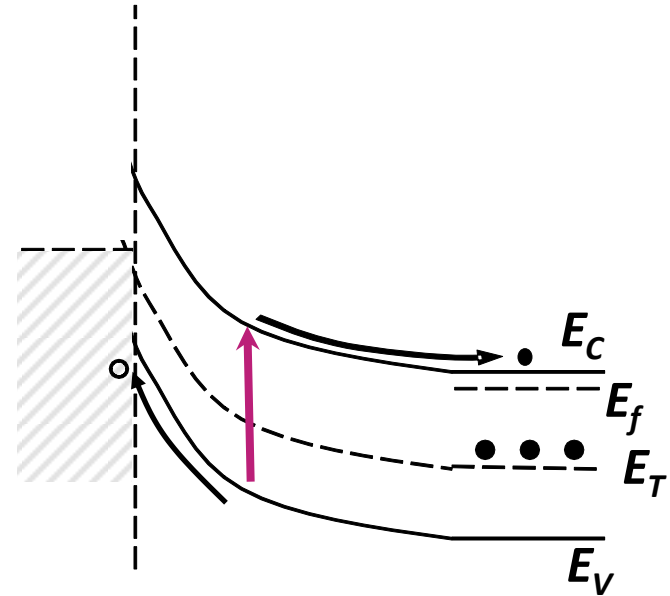
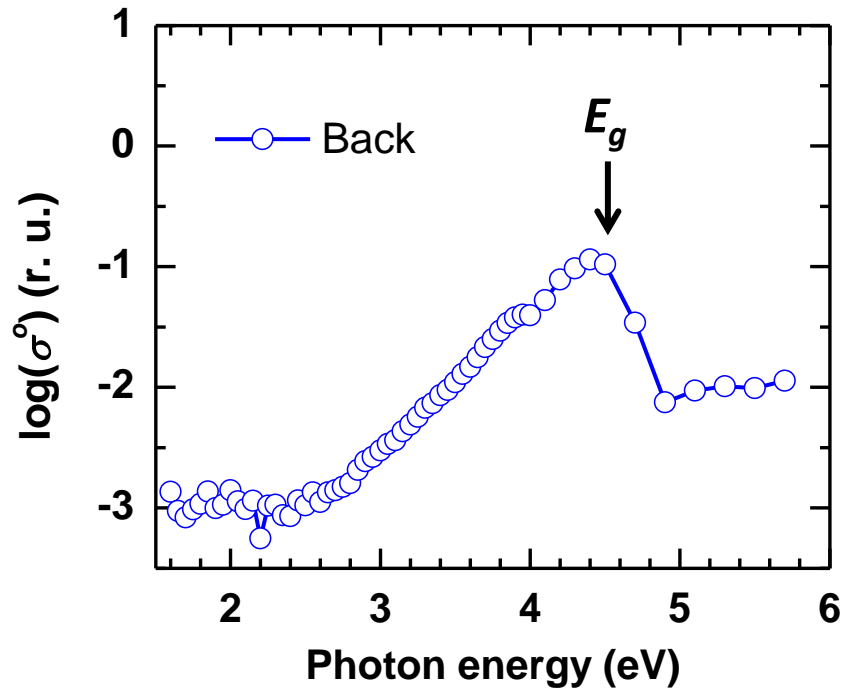
## Deep Level Optical Spectroscopy



➤ Backside: DLOS only senses deep level defects

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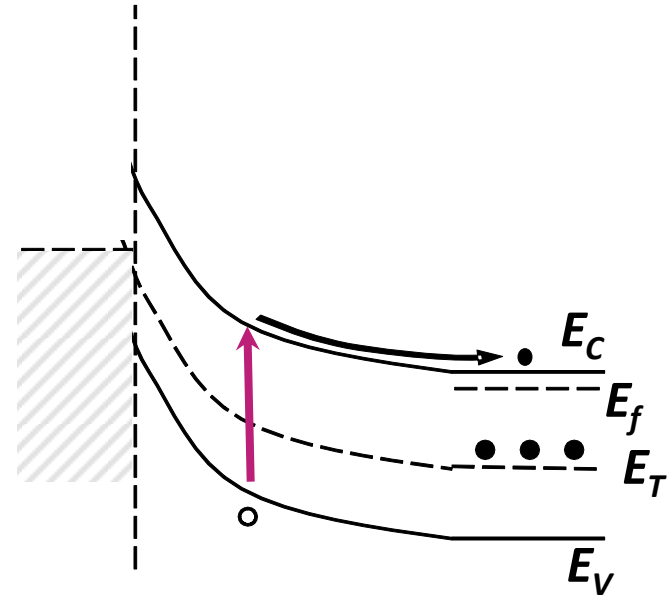
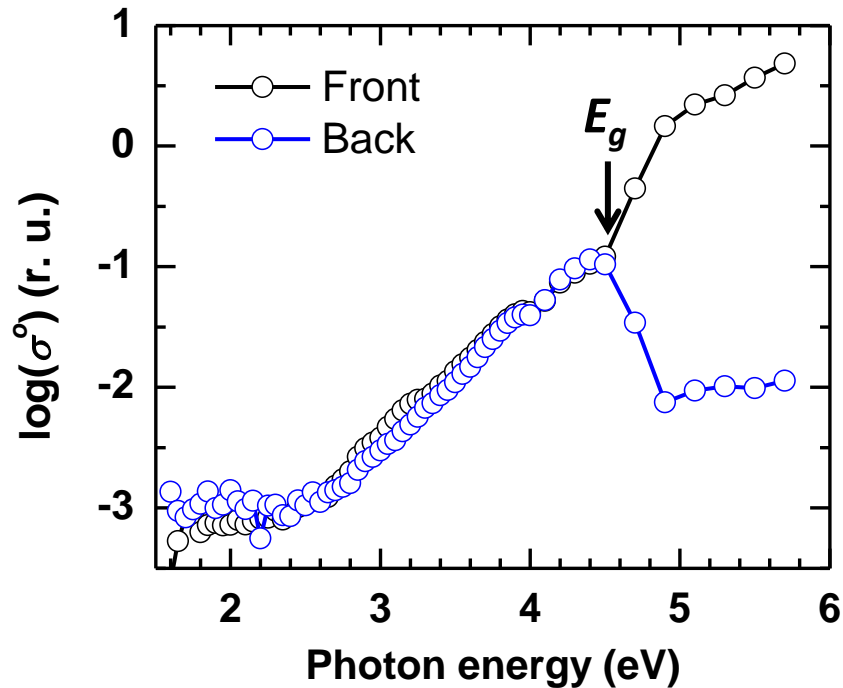
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## Deep Level Optical Spectroscopy

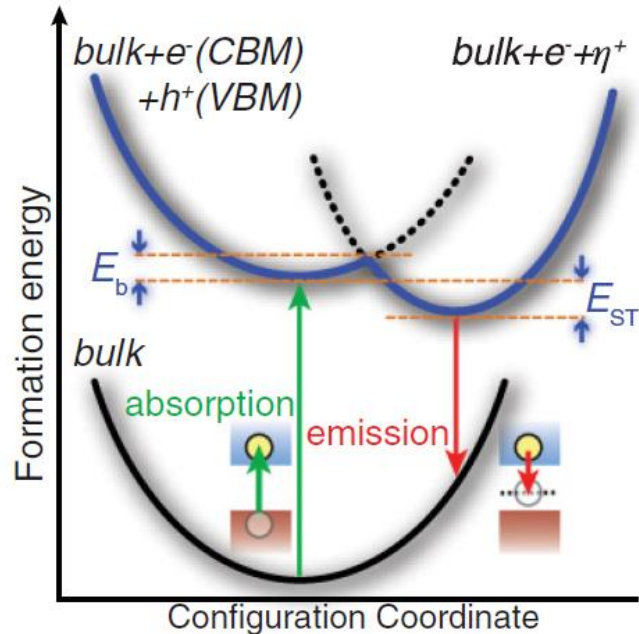


- Backside: DLOS only senses deep level defects
- Frontside: DLOS shows hole localization for above-gap illumination
- Hole localization unrelated to deep level defects



# Photo-gain from self-trapped holes

## STH configuration-coordinate

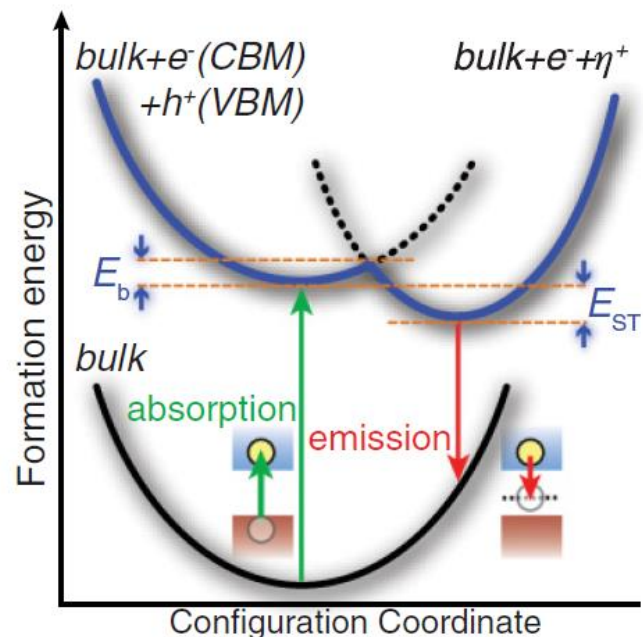


\*Varley, *et al.*, PRB 85 081109(R) (2012).

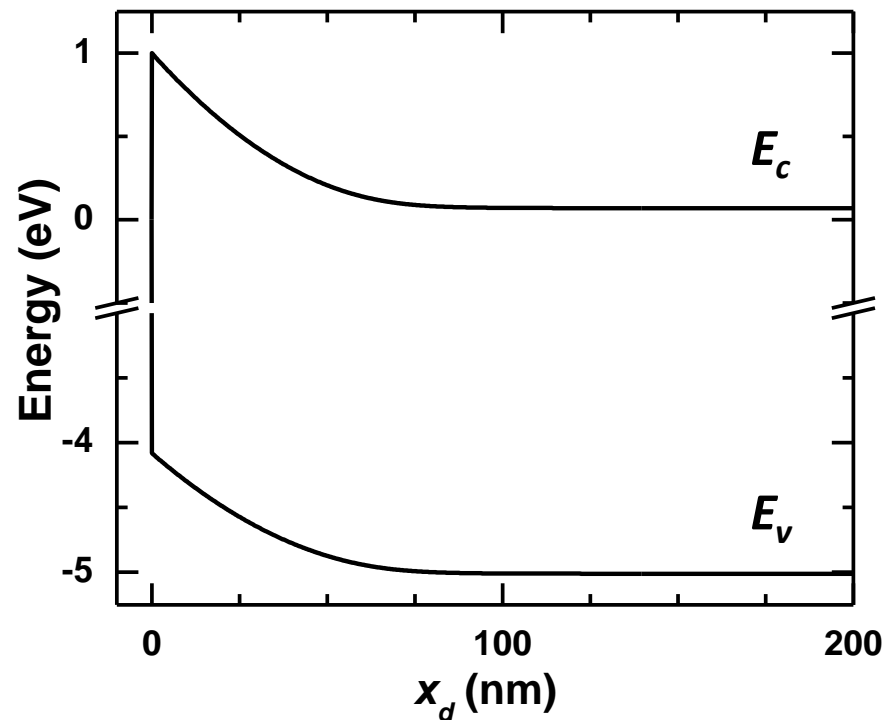
- Photo-gain can arise from self-trapped holes that behave similarly to an AX center\*
- Self-trapped holes form near the Schottky metal and lower  $\phi_b$ 
  - $\alpha \sim 10^6 \text{ cm}^{-1}$ #
- Intrinsic mechanism for long-lived holes in  $\beta\text{-Ga}_2\text{O}_3$

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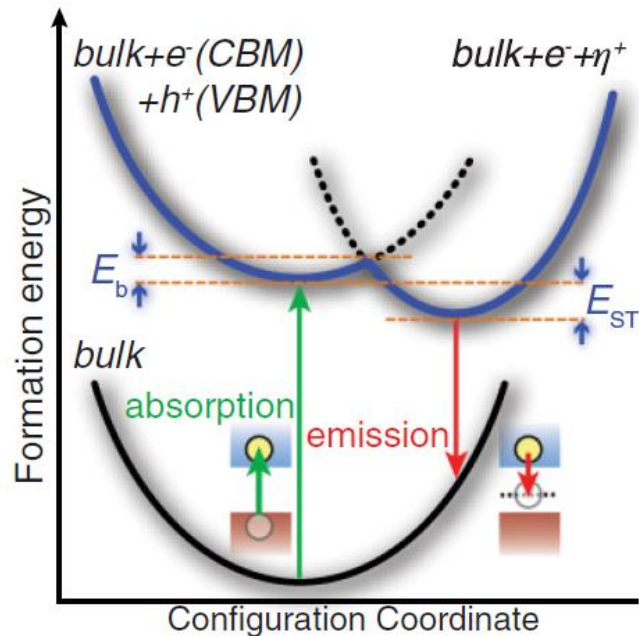
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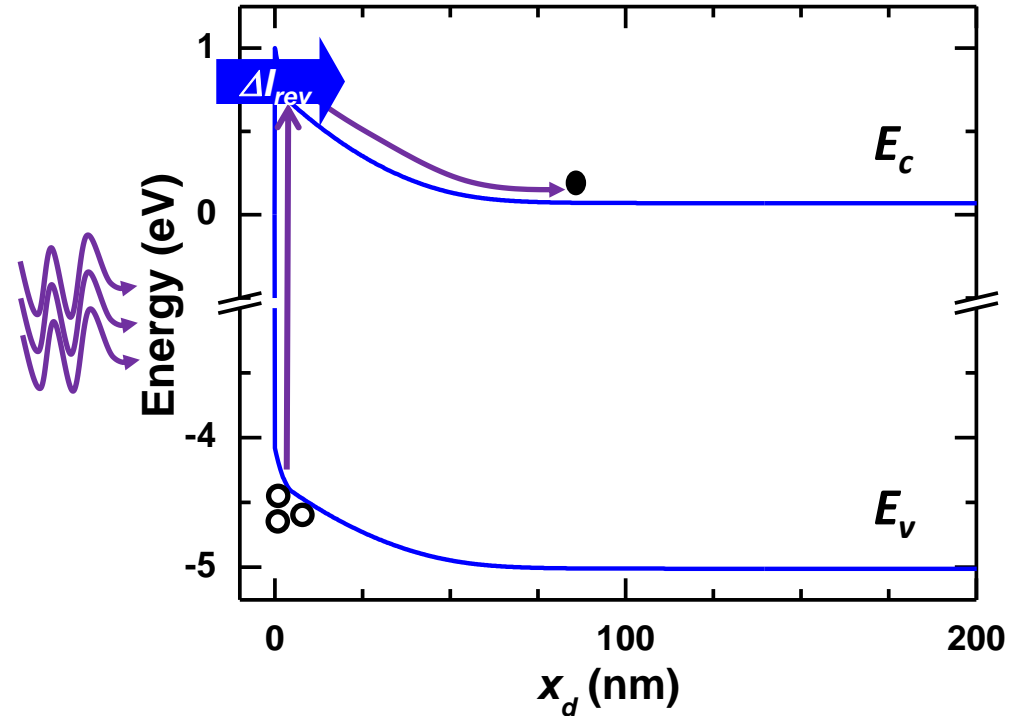
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