

# Comparison of the apparent temperature values ( $T_a$ ) in flip-chip and point contact mid-IR LEDs

(Appl. Phys. Lett. 89, 201114, 2006)

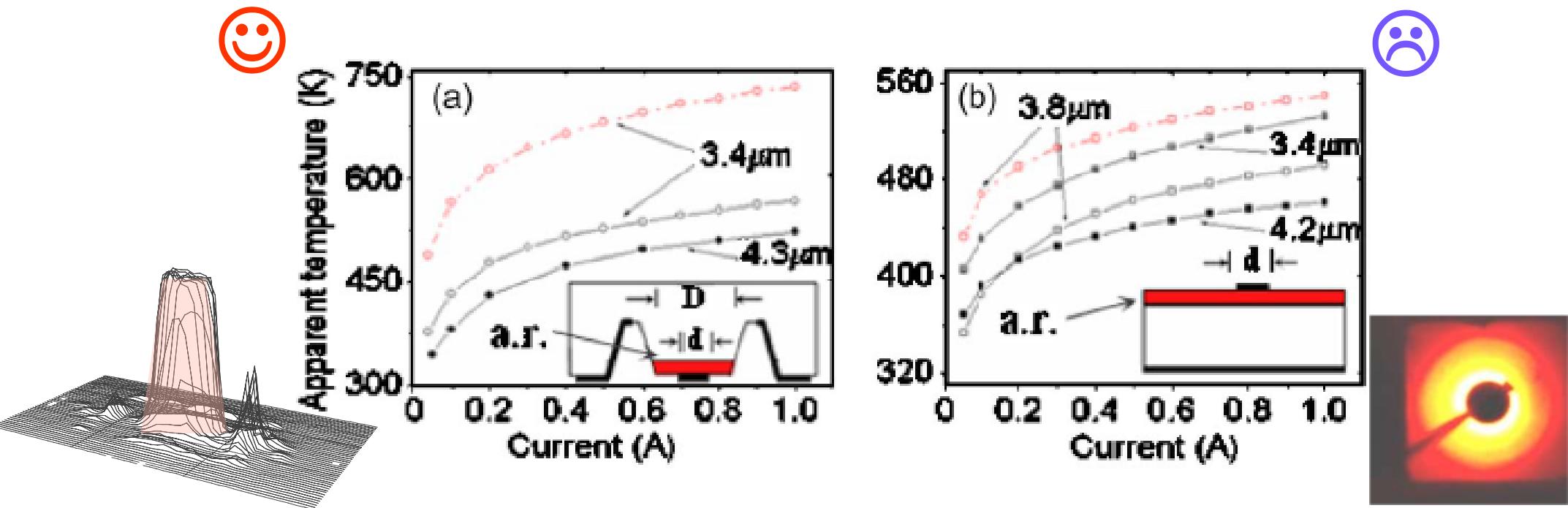
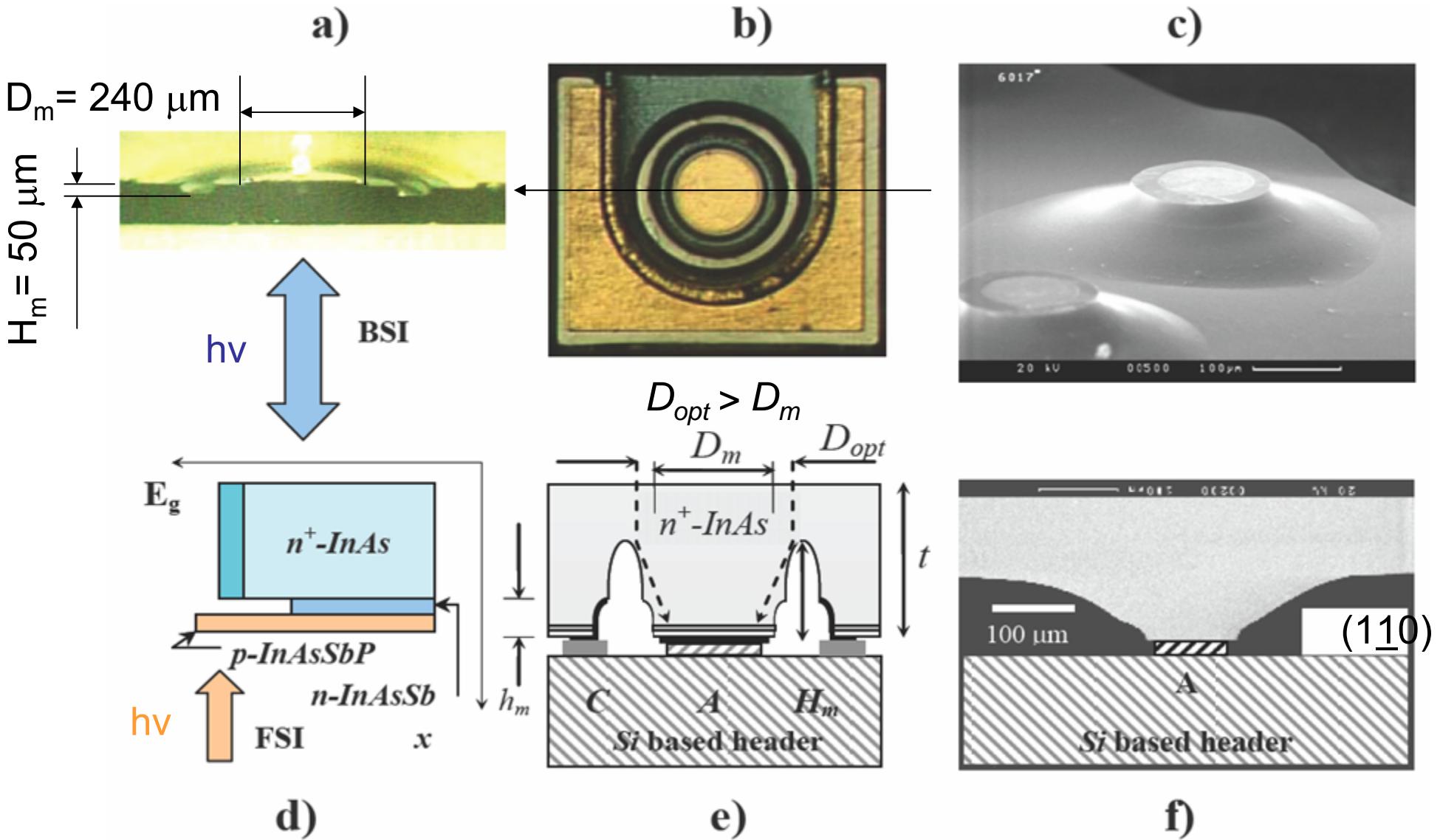


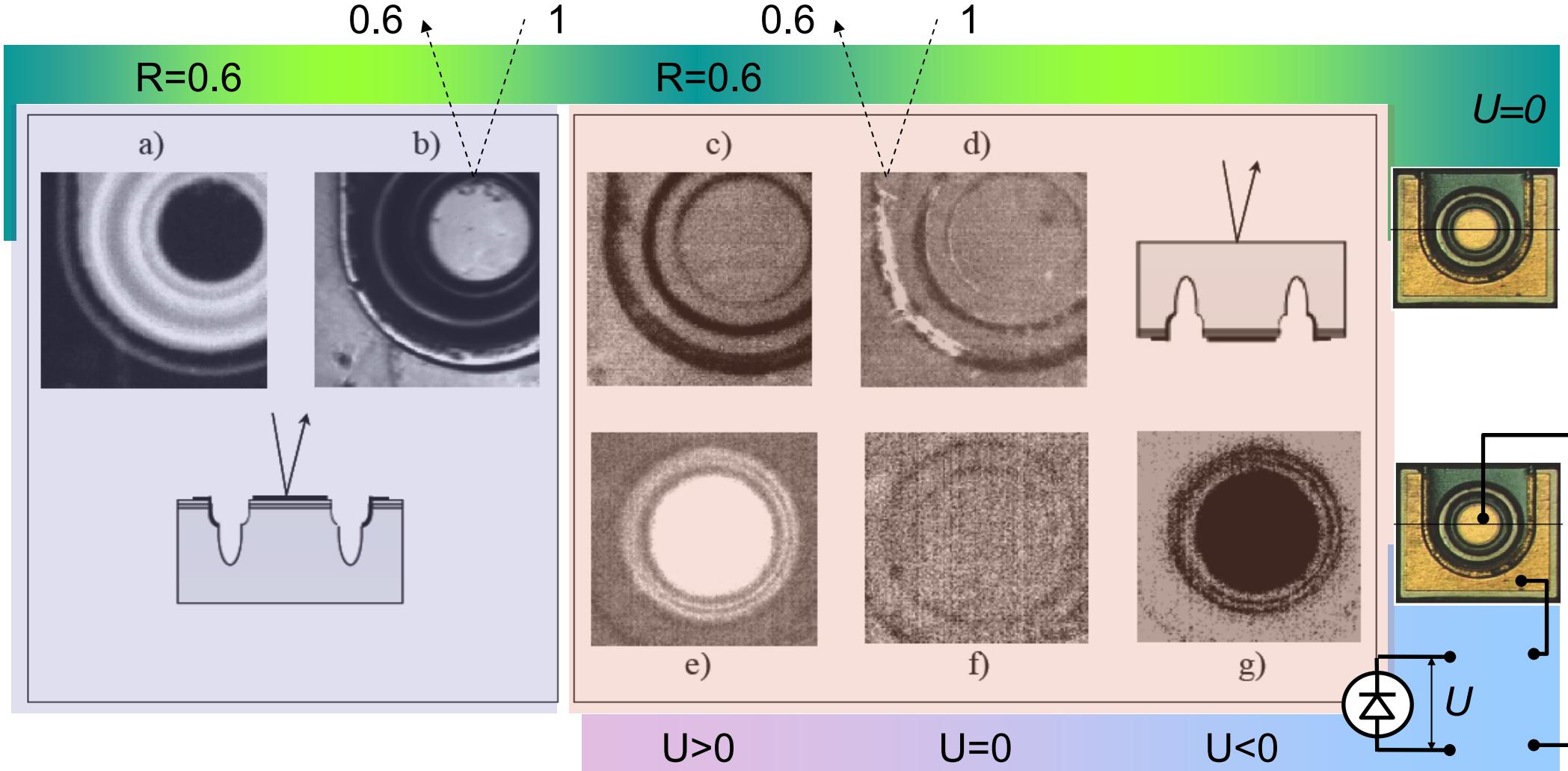
FIG. 1. (Color online) Measured  $T_a$ - $I$  dependencies for mesa (a) and planar (b) LEDs tuned at different  $\lambda_p$ . Dashed lines: narrow-band tests with filter passband  $\Delta\lambda/\lambda_p = 8.0\%$  and  $10.5\%$  for  $\lambda_p = 3.4$  and  $3.8 \mu\text{m}$ , respectively. Solid lines: MWIR-band tests. The insets are schematics of mesa and planar structures with active region (a. r.) shown in red.

# Characterization LEDs/PDs with internal concentrators

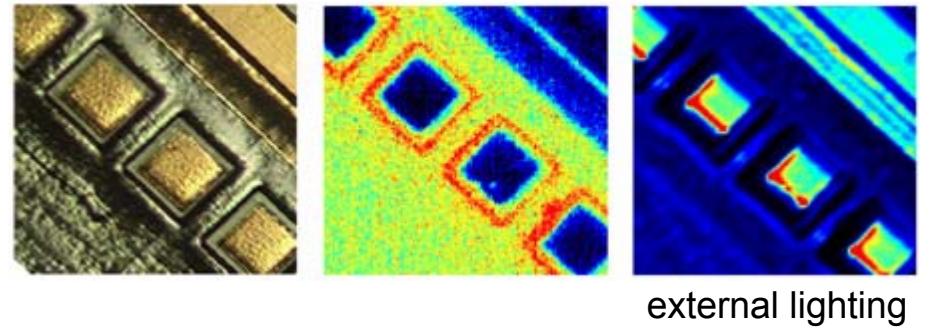
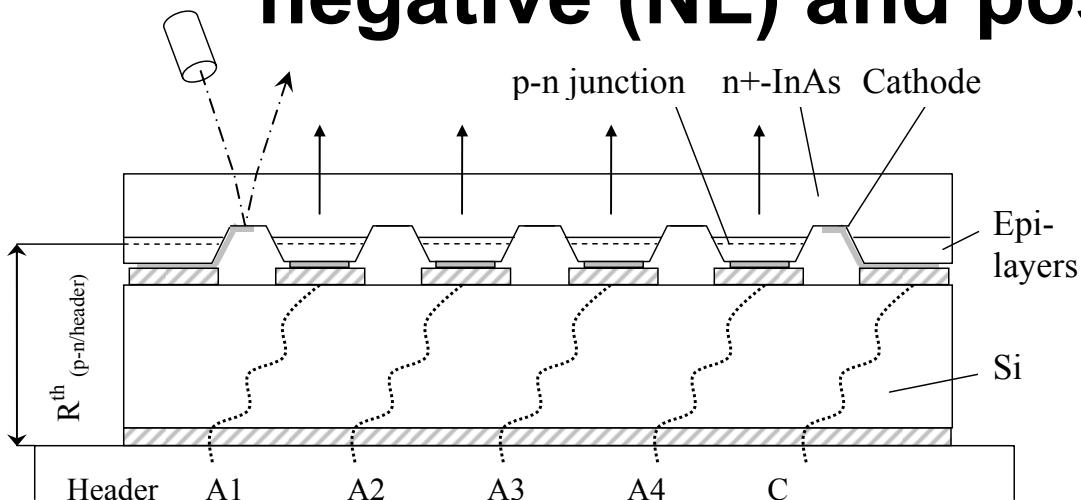


## Characterization

IR images of nonactivated (upper row) and activated (lower row) LED/PD chips measured from the epoxide (a, b - left group) and n<sup>+</sup>- InAs substrate (c, d, e, f, g - right group)

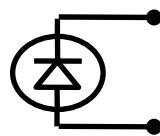
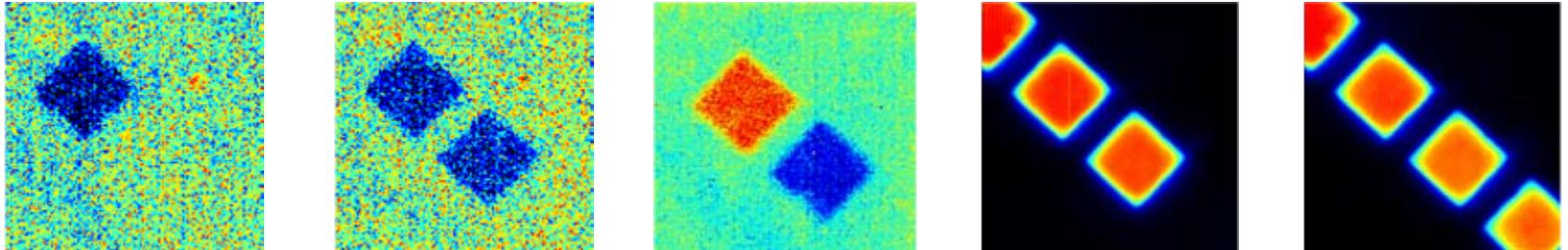


# IR imaging of 1x4 InGaAsSb LED arrays: negative (NL) and positive (PL) luminescence

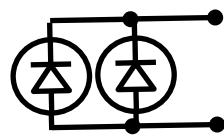


No bias (episide view)

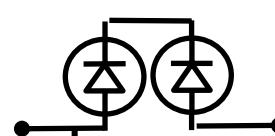
Element dimensions:  
130x130  $\mu\text{m}$ ,  
IR Image dimensions  
384x384  $\mu\text{m}$



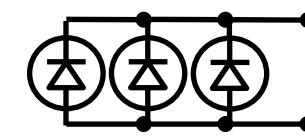
Substrate side view: NL



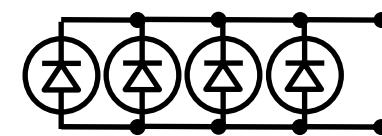
NL



NL+PL



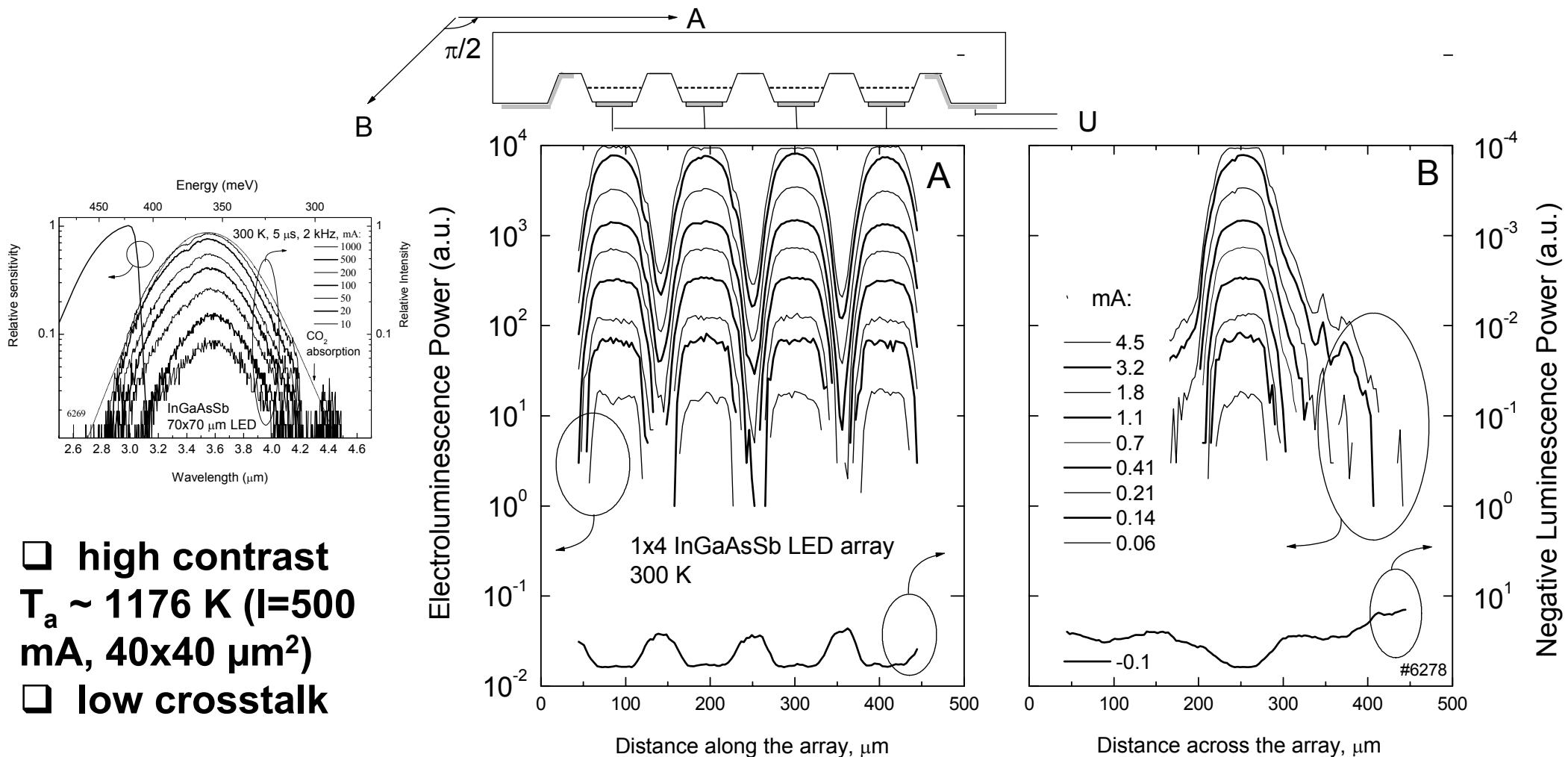
PL



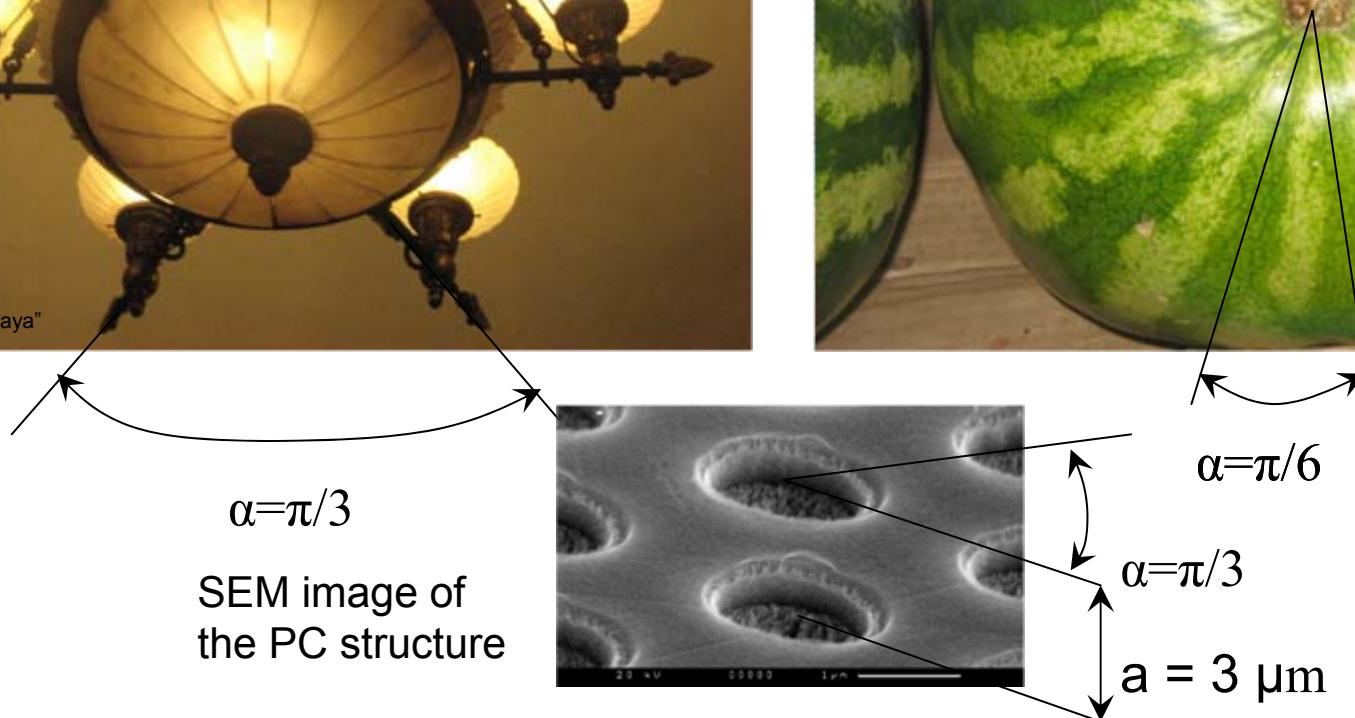
PL

## Characterization

# 1D emission distribution in 1x4 LED array ( $\lambda = 3.6 \mu\text{m}$ )



# Future trends: Photonic Crystal LEDs

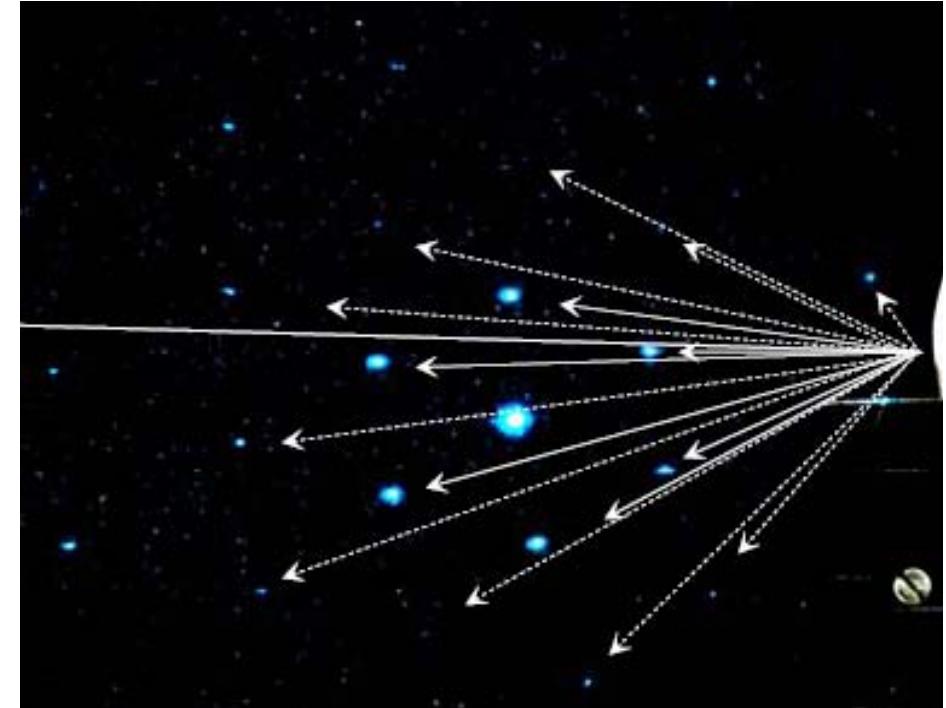
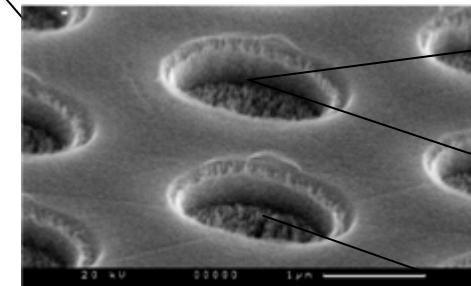


# Future trends: Photonic Crystal LEDs



$\alpha = \pi/3$

SEM image of  
the PC structure



$\alpha = \pi/6$

$\alpha = \pi/3$

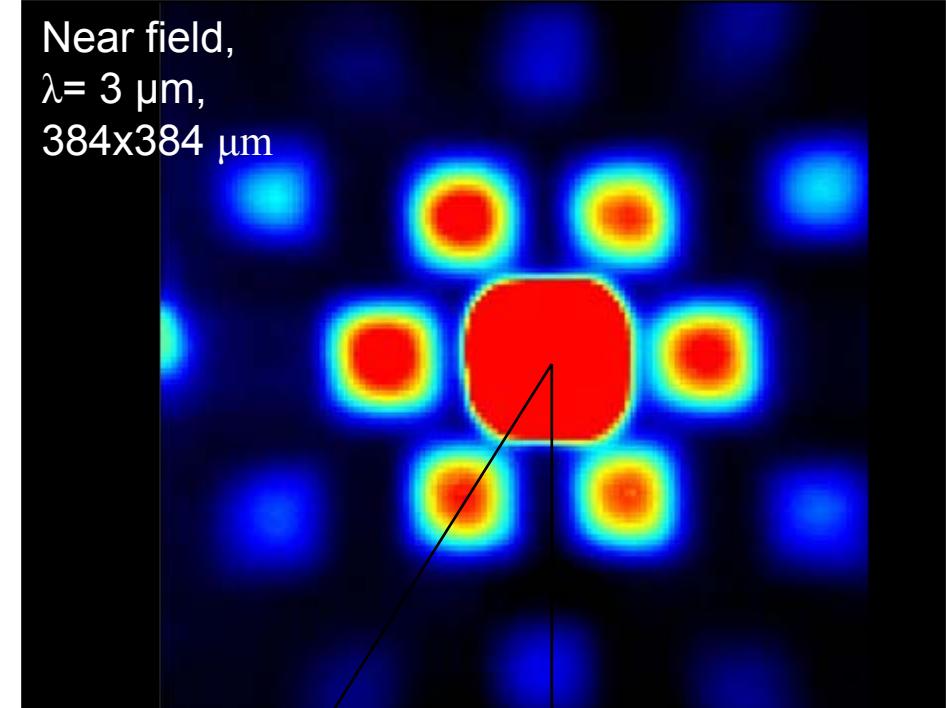
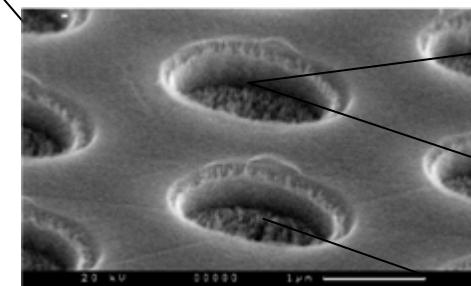
$a = 3 \mu\text{m}$

Diffraction of  
blue laser beam  
at the PC LED  
surface

# Future trends: Photonic Crystal LEDs



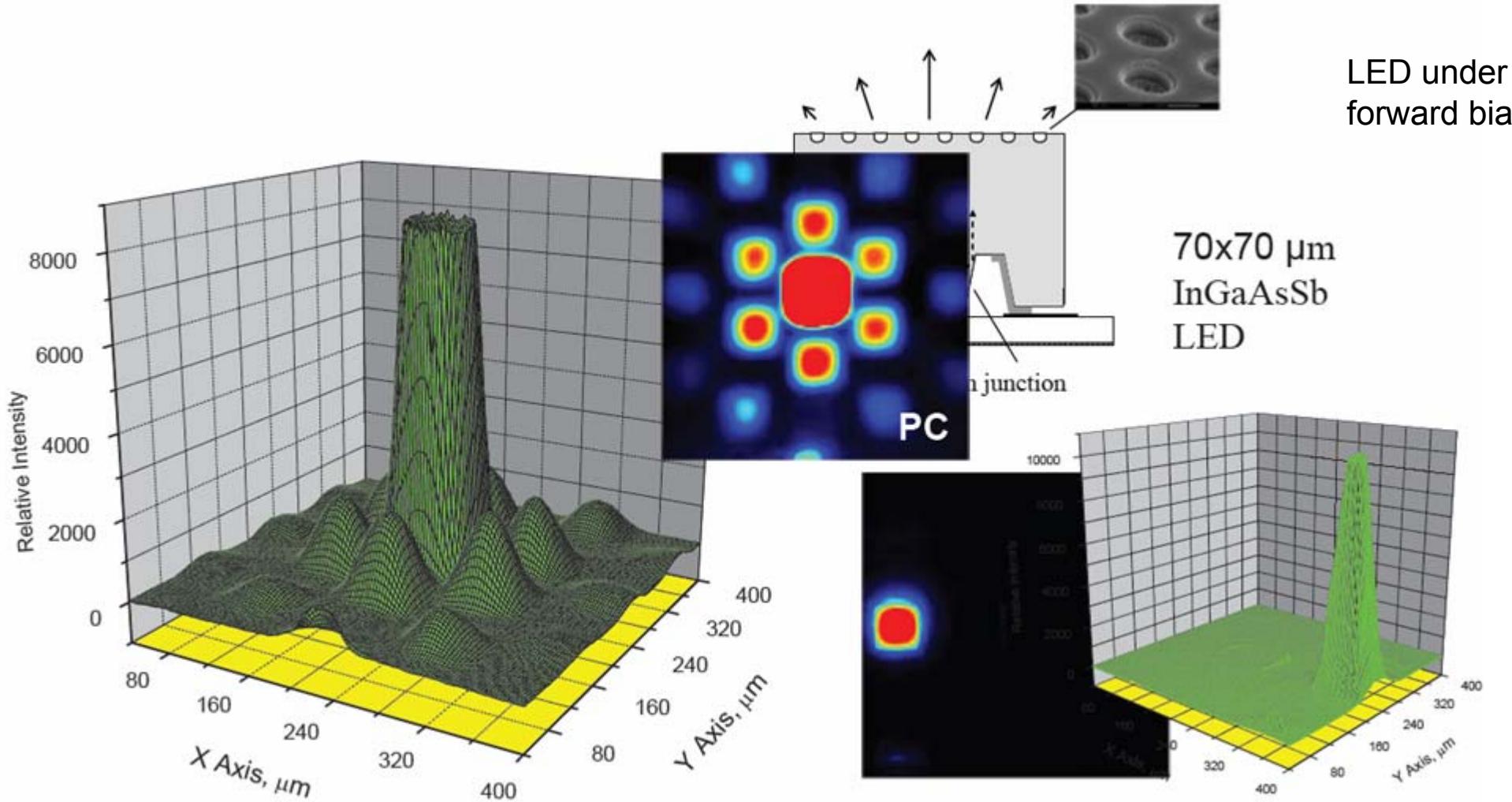
$\alpha = \pi/3$   
SEM image of  
the PC structure



$\alpha = \pi/6$  InGaAsSb  
PC LED  
under forward  
bias  
 $a = 3 \mu\text{m}$

*Future trends:*

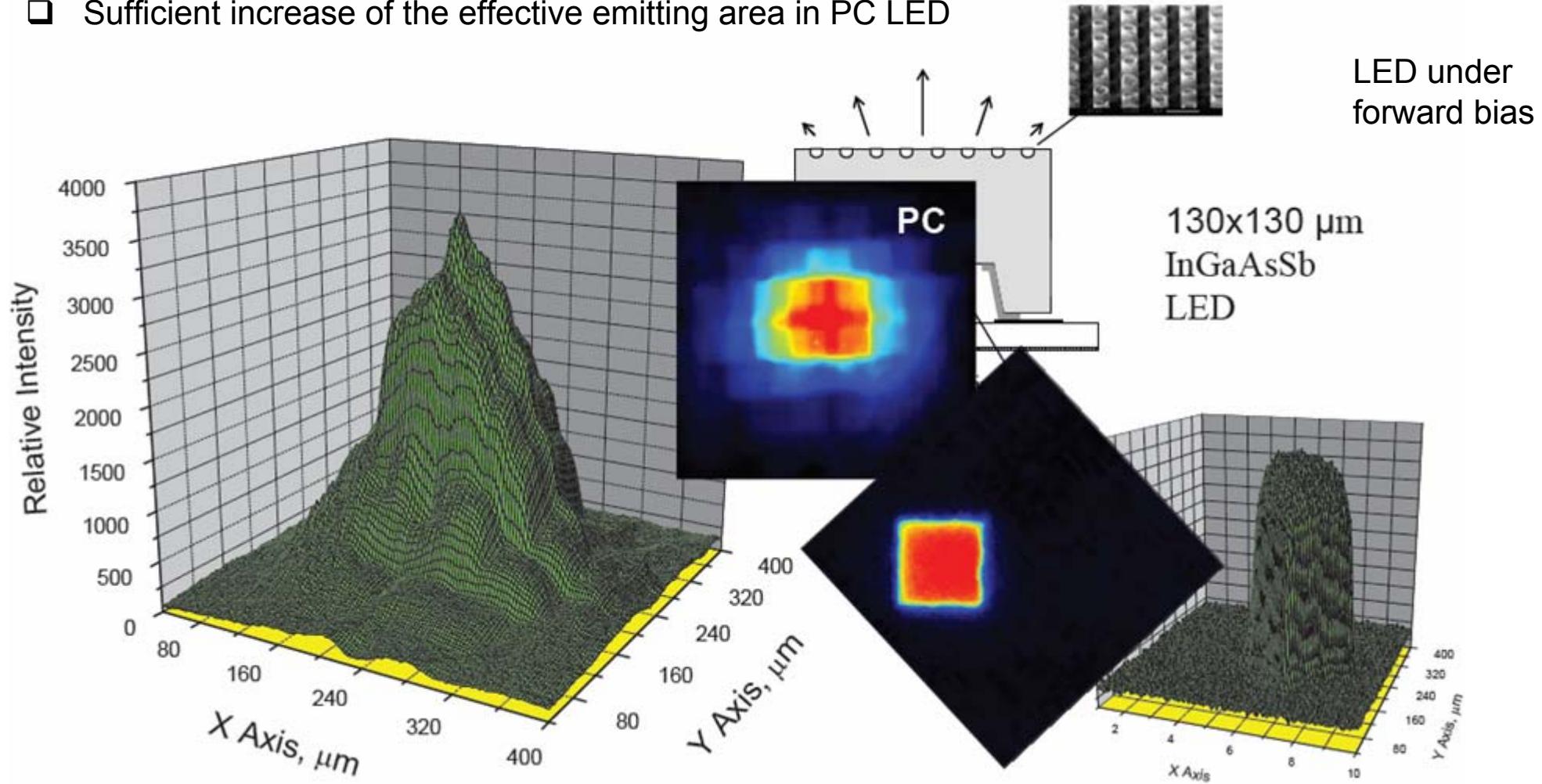
# Near field radiation distribution in PC LED



## *Future trends:*

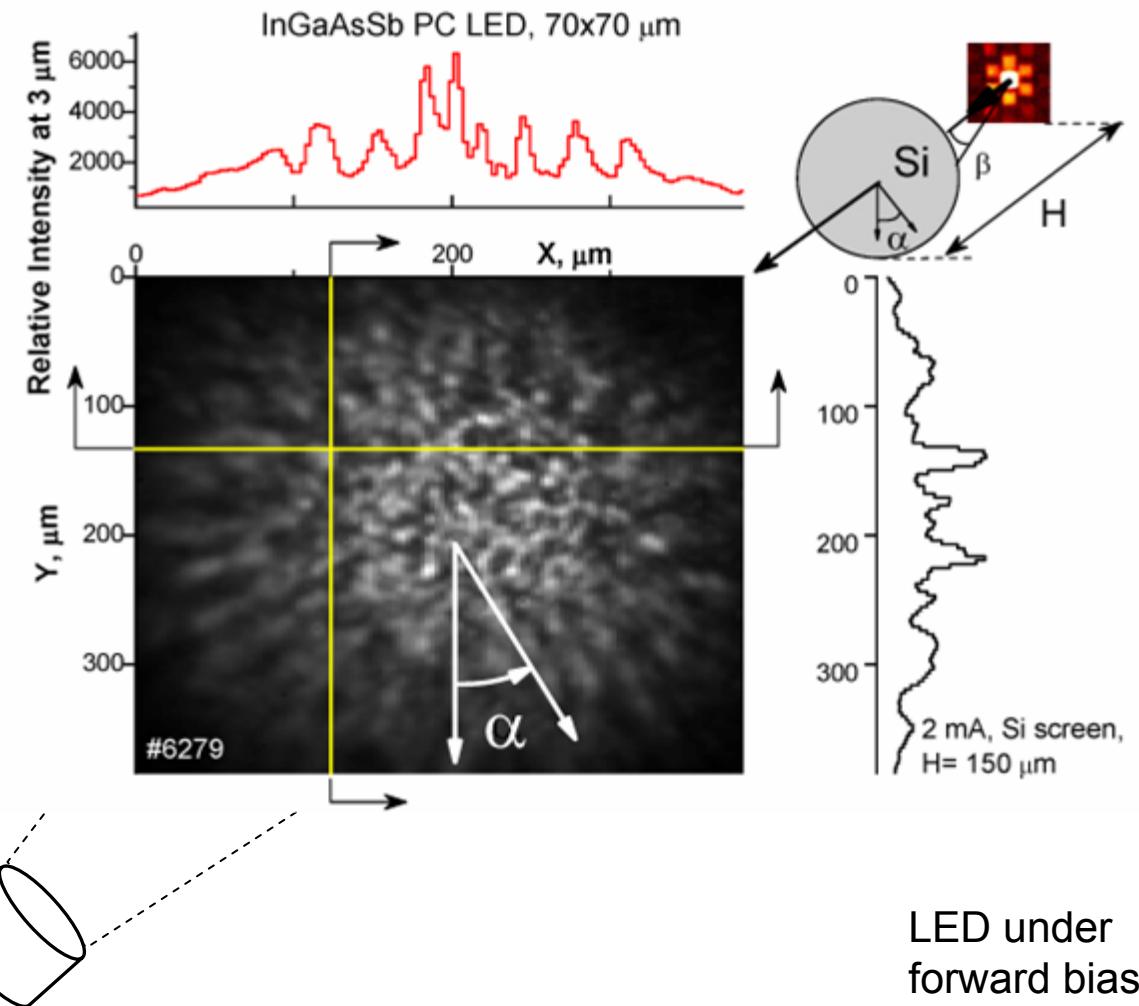
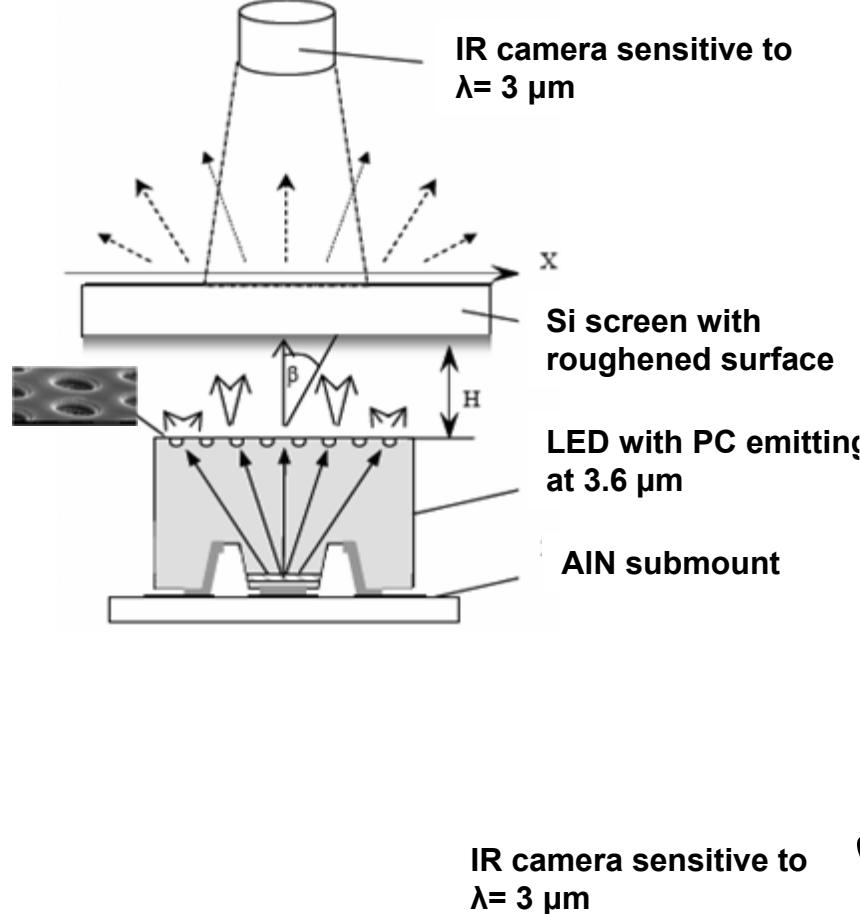
# Near field radiation distribution in PC LED

- Sufficient increase of the effective emitting area in PC LED

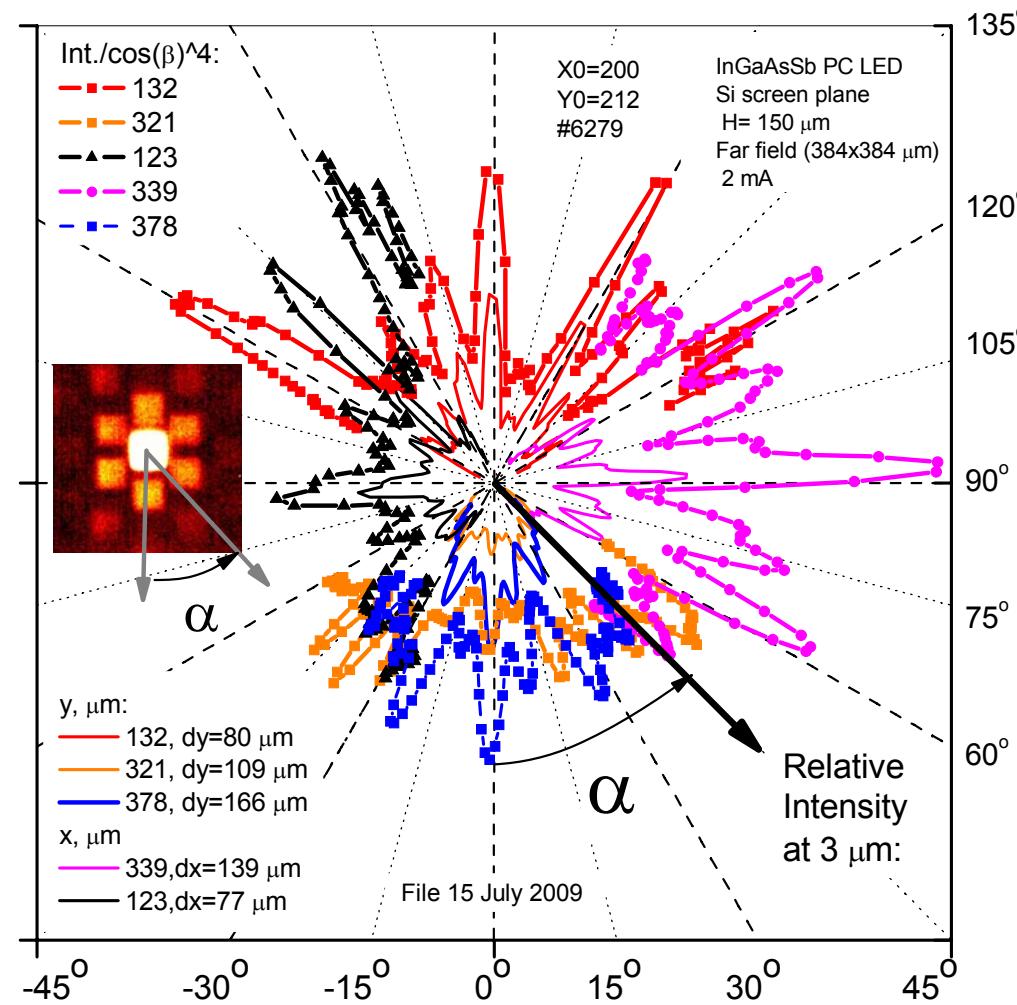


*Future trends:*

# Far field radiation distribution in PC LED



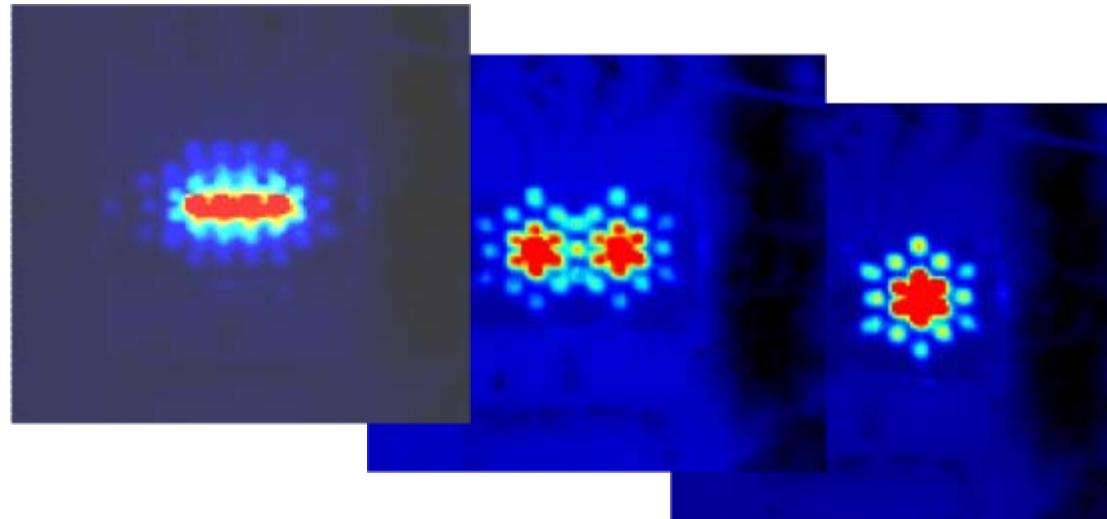
# Future trends: Far field radiation distribution in PC LED



LED under  
forward bias

*Future trends:*

# Near field radiation distribution in PC 1x4 LED array



4 diodes are biased

2 diodes are biased

Only 1 diode is biased

LED under  
forward bias