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High-resolution three-dimensional imaging of a depleted CMOS sensor using an edge Transient Current Technique based on the Two PhotonAbsorption process (TPA-eTCT)

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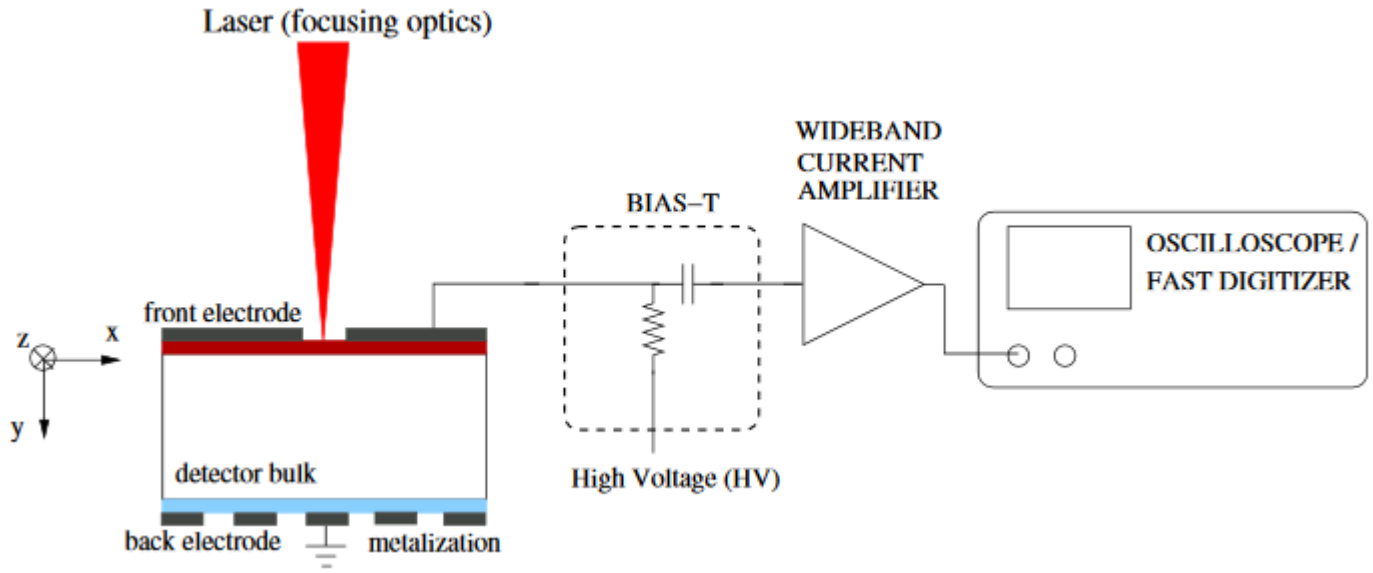
Introduction to TCT & TPA-TCT

- TCT, characterize silicon detector by carrier generation using **picosecond laser pulses**. Single Photon Absorption dominanted, carrier generation is induced along beam path. Laser wavelength is **above Si bandgap**($\lambda <= 1150nm$).

- TPA-TCT, only non-linear absorption is relevant. **Femtosecond pulses** are needed because TPA absorption probability is significant only for very short pulses. Laser wavelength is **below Si bandgap**($\lambda >= 1150nm$).
  - Advantage: both good spatial resolution and large penetration depth

Experimental arrangement

- Three-dimensional scan can be realized by:
  1. boundaties of the sensitive volume locate in the plane XY
  2. find focus point in Z-coordinate



Experimental results

HVCMOS map & Collection charge map & Collection time map

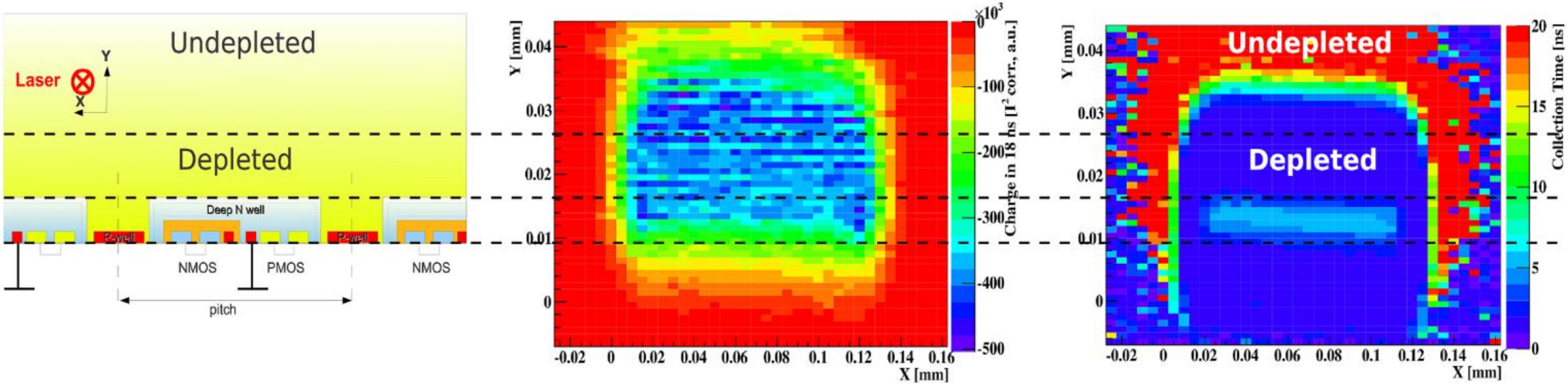


Fig. 1. Left: HVCMOS sketch. Center: charge collection map in 10 ns. Right: Collection time map. Measurements at 20C, −80 V.

Experimental results

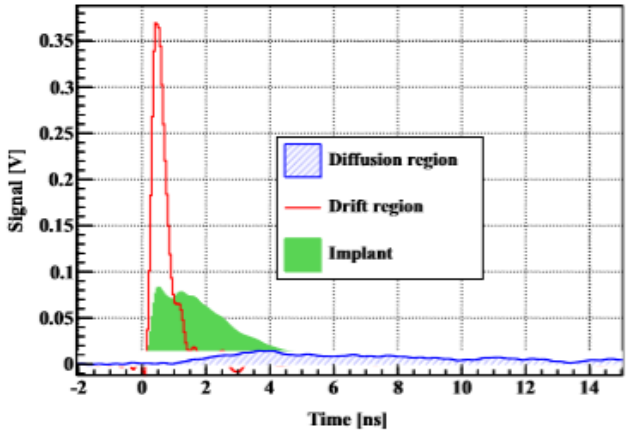


Fig. 2. Transient currents inside the DNW implant, depleted and diffusion regions of an HVCMOS sensor.

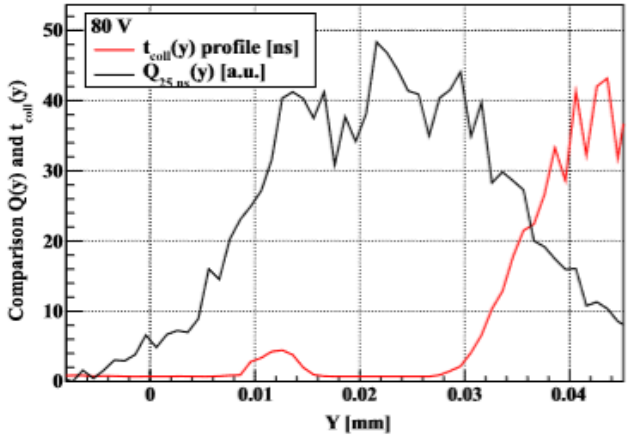


Fig. 3. Comparison (arbitrary vertical units) of collected charge profile (in 25 ns) with the collection time profile.

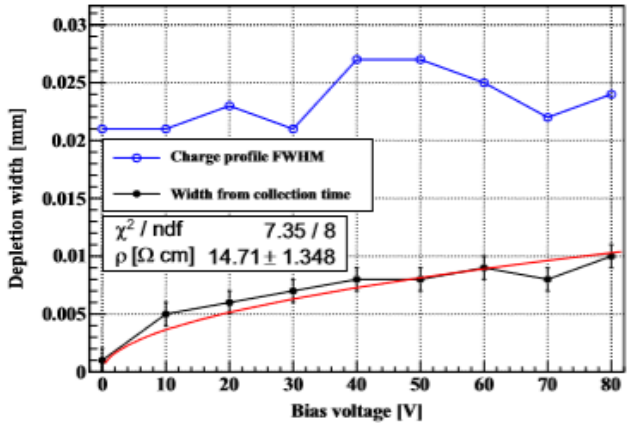


Fig. 4. Comparison of depletion depth calculated using charge profiles only (as in Fig. 1 center) or collection time profiles only (Fig. 1 right).

- Transient currents at each of these regions are compared.
- Time and charge can reflect the construction.
- Depletion thickness vs voltage.

Conclusions

- Dimension and geometry of the space charge region is measured, computing the effective doping concentration of silicon substrate.

Xin

- The resistivity ρ of the bulk can be calculated by fitting the measured depletion to w(V) (μm) = 0.3 sqrt(ρ)V, could you explain the meaning? Then, what does the nominal 10Ω cm mean?

- As I personally think, \pho can be got by fitting as a parameter. Depletion width is 0.01mm, we can get \pho 15Ω by the equation.

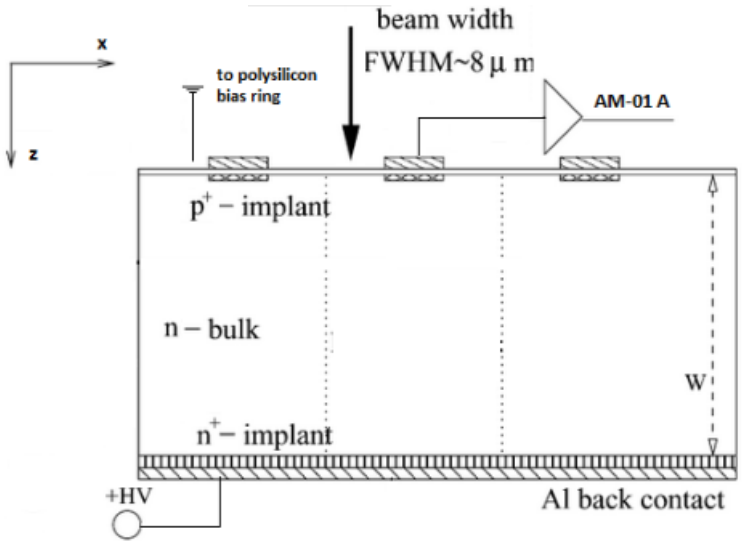
Yuhang

- In this paper, it say:"The unprecedented spatial resolution of this new method comes from the fact that measurable free carrier generation in two photon mode only occurs in a micrometric scale voxel around the focus of the beam." and “Very near infrared wavelengths (typically 1064 nm) can be collimated to ∼ 5 µm over several mm depth but carriers are generated along the whole beam path lacking point spatial resolution."Does this mean in TPA-TCT carriers aren't generated along the whole beam path?

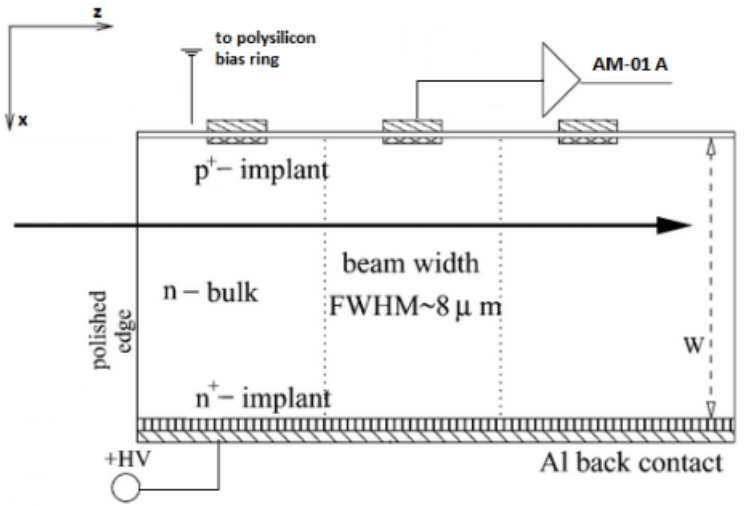
- In TPA, focused light generates photocarriers only in a localized volume around the focus. That’s the reason why it’s able to spatially resolve implants.

Back-up

- Top TCT & Edge TCT



(a) Top-TCT Configuration



(b) Edge-TCT Configuration