High-resolution three-dimensional imaging of a depleted CMOS sensor using an edge Transient Current Technique based on the Two Photon Absorption 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 dominated, carrier generation is induced along beam path. Laser wavelength is **above Si bandgap** (λ<=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** (λ>=1150nm).
  • Advantage: both good spatial resolution and large penetration depth
Experimental arrangement

- Three-dimensional scan can be realized by:
  1. boundaries 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 20°C, −80 V.
Experimental results

- 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 $\rho$ of the bulk can be calculated by fitting the measured depletion to $w(V) (\mu m) = 0.3 \sqrt{\rho} V$, could you explain the meaning? Then, what does the nominal $10\Omega$ cm mean?

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