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Stimulated Raman Scattering Imager Using Lateral Electric Field Charge Modulator

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1 Introduction

Stimulated Raman scattering (SRS) imaging provides background-free chemical imaging with improved image contrast. Since the generated Raman signal is very low to be readout, a high-speed modulation lock-in pixel using differential charge accumulation and offset canceling to achieve high dynamic range is used.

2 Lateral Electric Field Charge Modulator

Fig. (1a) shows a lock-in pixel structure of the photo-charge modulator with lateral electric field control. The pixel use pinned photodiode and two sets of gates (G_1 and G_2) for applying a lateral electric field. The gates are not used for draining the photo charge but for controlling the electric field of $X - X'$ direction. A relatively small positive voltage (M=1.3V) and negative voltage (L=-2V) are used for the operation where the potential profile in X-X' is shown in Fig. (1b)

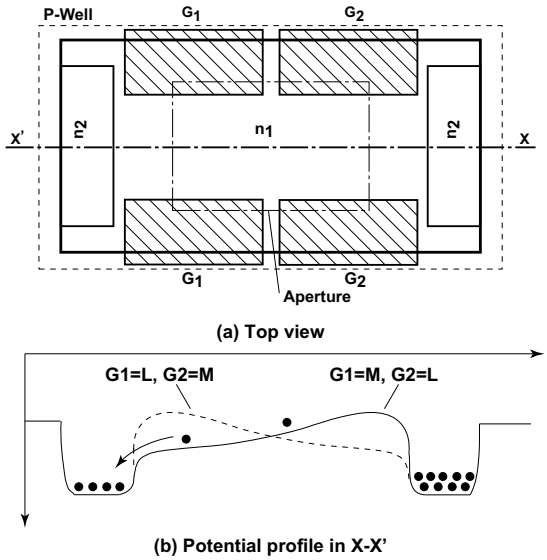

Figure 1: Lateral Electric Field Charge Modulator

3 Lock-in Pixel Readout Circuit

Fig. (2) shows the proposed readout circuit using a lock-in pixel fully differential amplifier with sampling circuit. After resetting the amplifier through RT, ϕ_1 is turned on first to set C_2 to V_{com} level, then ϕ_{1d} is turned on and C_2 is being charged. In second step ϕ_1, ϕ_{1d} are turned off and ϕ_2 is turned on to transfer the charge to C. The phase delay Δt between the modulated pixel output signal and ϕ_1, ϕ_{1d} and ϕ_2 needs to be carefully adjusted. Fig. (3) shows parametric simulation by tuning the phase delay Δt. The lock-in amplifier differential output $VOP-VON$ is plotted as a function of accumulation time for different values of Δt. The input nodes are supposed to have the same values at V_1 and V_2 when there is no incident light. By adjusting the phase delay, the amplifier differential output is equal to zero for $\Delta t = 584ps$. This LEFM structure does not have a problem of the creation of potential barrier at the edge of transfer gate, and charge trapping under the gate (Si-SiO2 interface). Therefore, very high-speed electron transfer less than $1ns$ is possible using the LEFM.

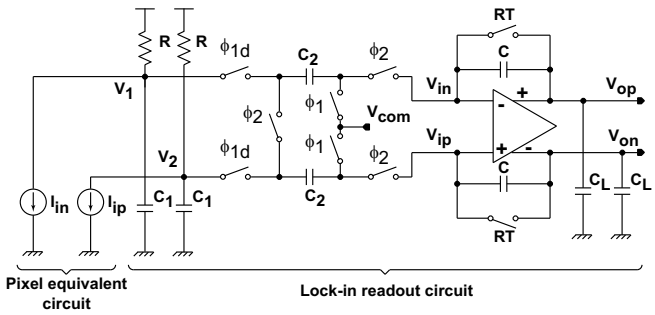

Figure 2: In Pixel Readout circuit.

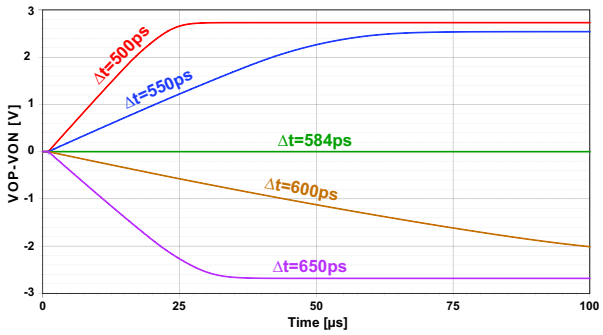

Figure 3: Parametric simulation of Δt for $\Delta I = 0$

4 Conclusion

High-speed lateral electric field charge modulator lock-in pixel is very effective, by monitoring the phase delay between the modulated pixel output signal and the readout clock, the offset signal is canceled and high dynamic range can be achieved.