UNIVERSITY OF CAMBRIDGE

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How to Achieve High Photoconductive Gain for Transparent Oxide Semiconductor Image Sensors

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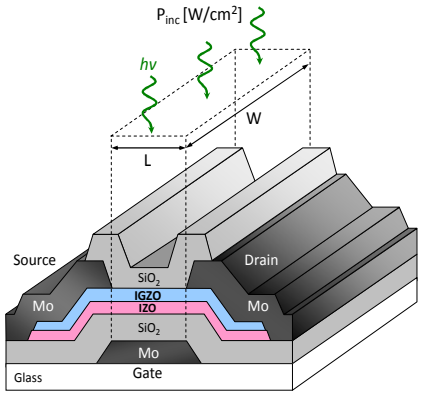
Introduction

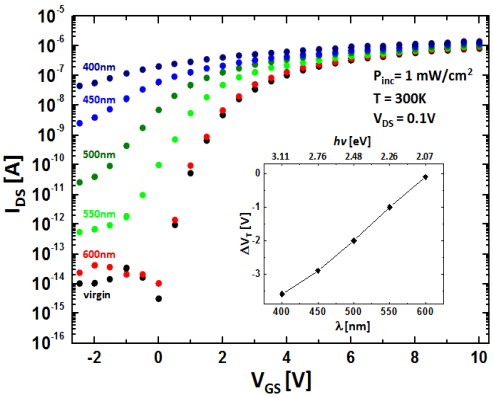
- A quantitative analysis of a high photoconductivity in amorphous oxide semiconductor (AOS) thin film transistors (TFTs), taking into account the sub-gap optical absorption in oxygen deficiency defects.

Results and Discussions

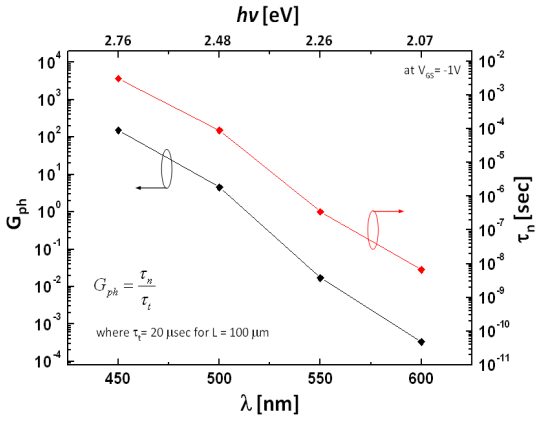
- Photo-TFT structure:



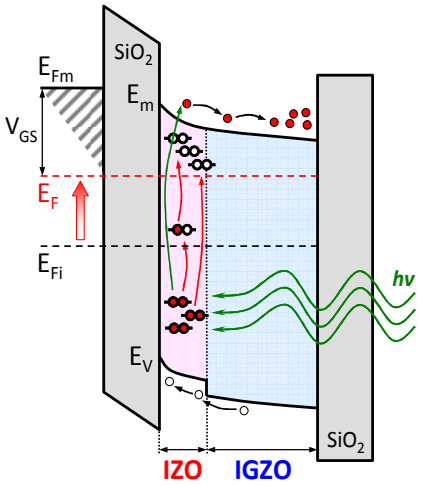
- I-V characteristics under light:



- Carrier life-time and G_{ph}:

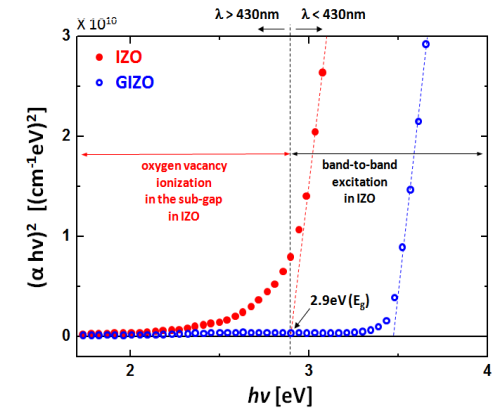


- Oxygen defect ionization:

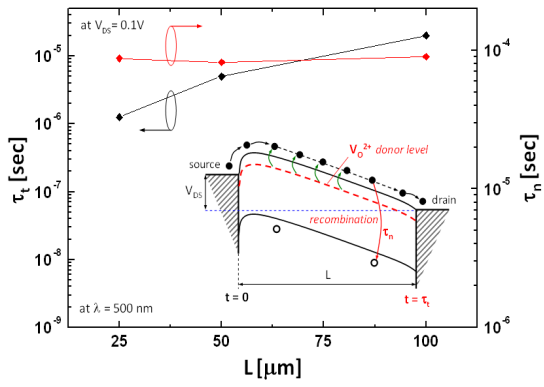


$$P_{abs} = P_{inc}[1-\exp(-\alpha \cdot T_{IZO})] \qquad n(V_O^{2+}) \approx \frac{C_{ox}^2}{2\varepsilon_S kT}\Delta V_T^2 \qquad G_{ph} = \frac{\tau_n}{\tau_t} \qquad \tau_t = \frac{L^2}{\mu_{eff} V_{DS}} \qquad \tau_n = \frac{n(V_O^{2+})}{R \cdot n_i^2}$$

- Tauc plot for IZO and IGZO layers:



- Channel length dependency:



Conclusion

- Basis of photoconductivity in AOSs analyzed to be explained in terms of the extended electron lifetime due to retarded recombination as a result of hole localization.
- Photoconductive gain in AOS photo-TFTs maximized by reducing the transit time associated with short channel lengths, making device scaling favourable for high sensitivity operation.

Related Publications:

- Sungsik Lee *et al.*, ***IEEE IEDM*** (2012).
- Arokia Nathan *et al.*, ***IEEE Journal of Display Technology*** 10, 917 (2012).