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Conduction Threshold in Thin Film Transistors

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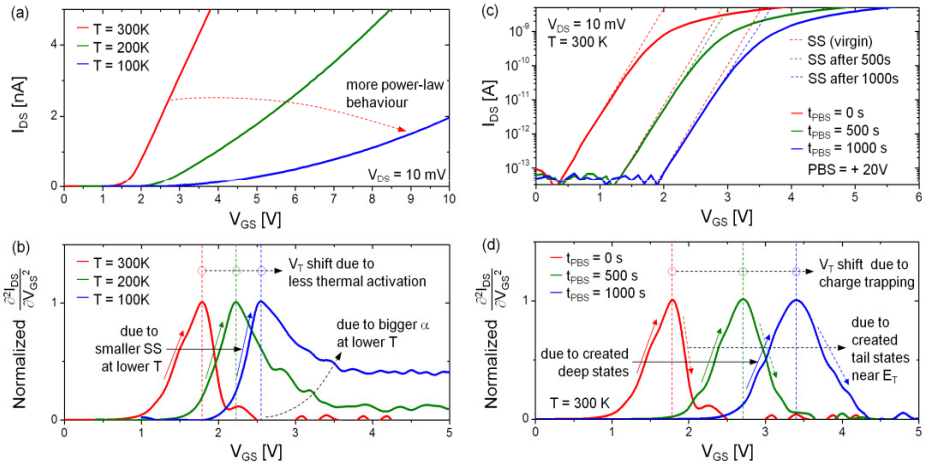
Introduction

- Accumulation threshold described as the transition of the Fermi level from deep to tail states, and defined as the juxtaposition of linear and exponential dependencies of the carrier density on surface potential.
- Consistency with a microscopic state where trap-limited conduction ratio increases most rapidly.

- Empirical observation:



Results and Discussions

- Poisson-Boltzmann equation and physical definition of V_T:

$$\varphi_S = \frac{kT}{q}\ln\left(\frac{n_{free}(V_{GS})}{N_C}\right) - \frac{(E_{F0}-E_C)}{q} \equiv f(V_{GS})$$

$$E_S \equiv g(V_{GS}) = \sqrt{\frac{2q}{\varepsilon_S}\int_0^{\varphi_S} n_{tot}\,d\varphi}$$

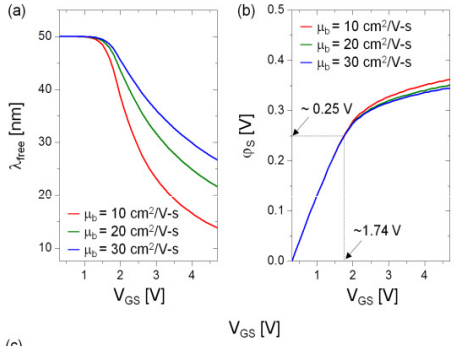
$$n_{tot}(\varphi_S) = \frac{\varepsilon_S}{2q}\frac{\partial\left(g(f^{-1}(\varphi_S))\right)^2}{\partial\varphi_S}$$

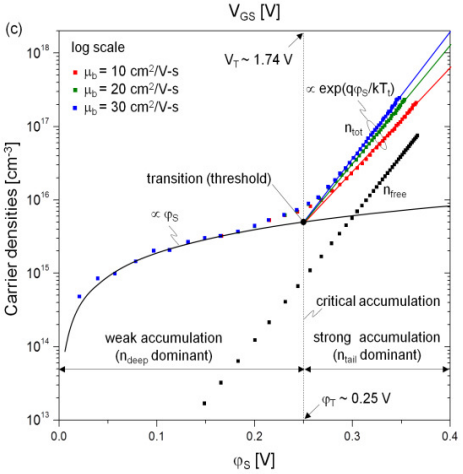
$$\chi_{TLC} \equiv \frac{n_{free}}{n_{free}+n_{deep}+n_{tail}} \propto \frac{\partial I_{DS}}{\partial V_{GS}}$$

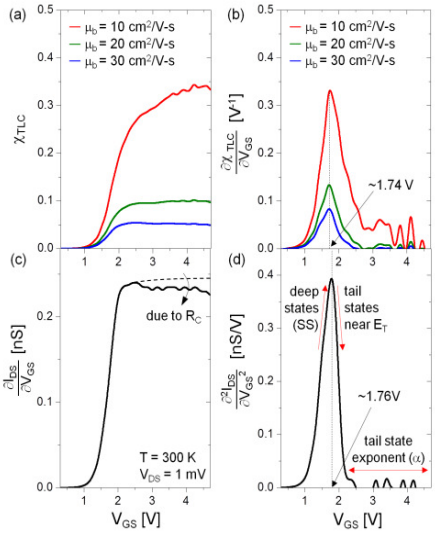
$$\frac{\partial \chi_{TLC}}{\partial V_{GS}}\ peaked at V_{GS} = V_T$$

$$\Leftrightarrow$$

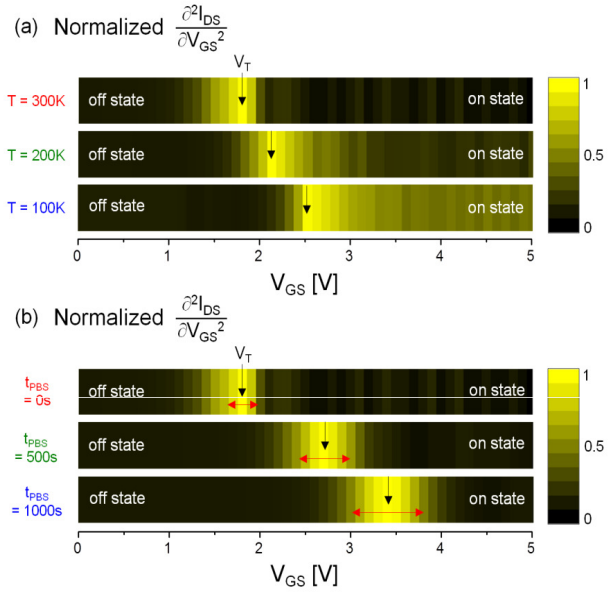
$$\frac{\partial^2 I_{DS}}{\partial V_{GS}^2}\ peaked at V_{GS} = V_T$$







- Image spectroscopy:



Conclusion

- Conduction threshold identified to take place at the transition of the Fermi level from localized deep to tail states, which consistent with the peak of a relative dominance of free carriers against trapped carriers in accordance of trap-limited conduction theory.

Related Publication: • Sungsik Lee *et al.*, ***Scientific Reports*** (NPG) 6, 22567, 2016.

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