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Localized Tail State Distribution in *a*-Oxide TFTs deduced from Low Temperature Measurements

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Introduction

- Density of localized tail states retrieved from measurements of low temperature conduction in amorphous oxide semiconductor thin film transistors.

Results and Discussions

- Derivation of key relations for density of tail states:

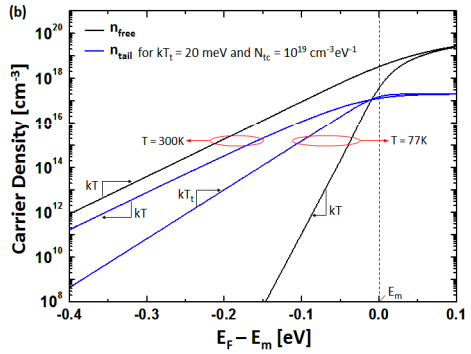
$$N_{tail}(E) \approx N_{tc}\exp\left(\frac{E-E_m}{kT_t}\right) \qquad n_{tail} = \int_{E_{F0}}^{E_m} N_{tail}(E)f(E)dE$$

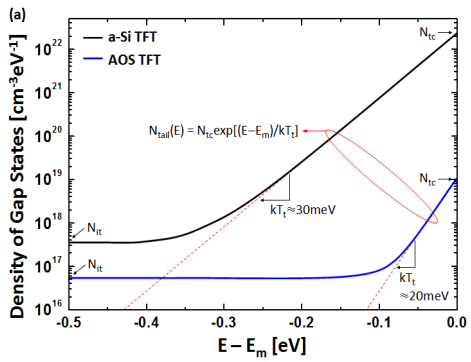
$$n_{tail} \approx \frac{1}{2}N_{tc}kT_t\left(\frac{2(E_F-E_m)}{kT_t}\right)^{kT_t/kT}\exp\left(\frac{E_F-E_m}{kT}\right) \quad for\ kT > kT_t$$

$$n_{tail} \approx N_{tc}kT_t\exp\left(\frac{E_F-E_m}{kT_t}\right) \quad for\ kT < kT_t \qquad \left.\frac{\partial n_{tail}}{\partial E_F}\right|_{E_F\to E} = N_{tc}\exp\left(\frac{E-E_m}{kT_t}\right) \approx N_{tail}(E)$$

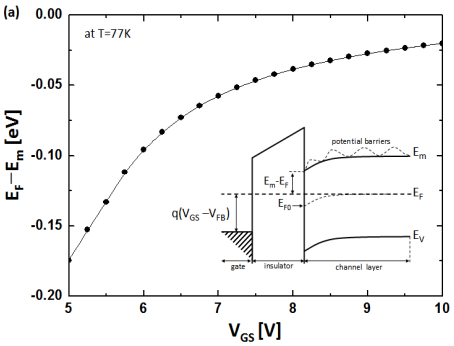
$$\int_{E_{F0}}^{E_m} N_{tail}(E)f(E)dE\Big|_{T\to 0} = \int_{E_{F0}}^{E_F} N_{tail}(E)f(E)dE \qquad E_F - E_m = \frac{2kT}{q}\ln\left[\frac{\sigma_{DS}(V_{GS})}{\sqrt{N_C\varepsilon_S kT\mu_0(W/L)}}\right]$$

- Carrier density and gap state profiles:

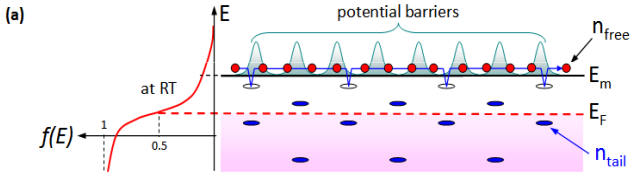


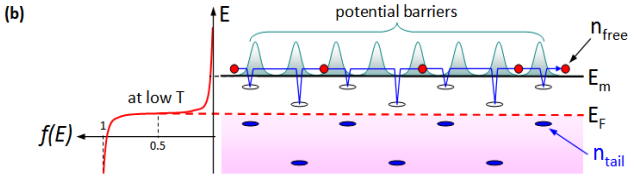


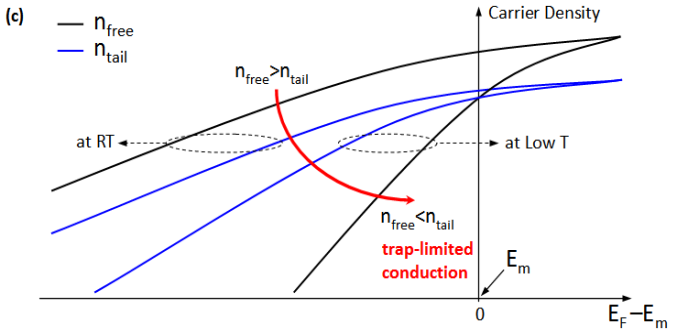
- Correspondence between E_F and V_{GS}:



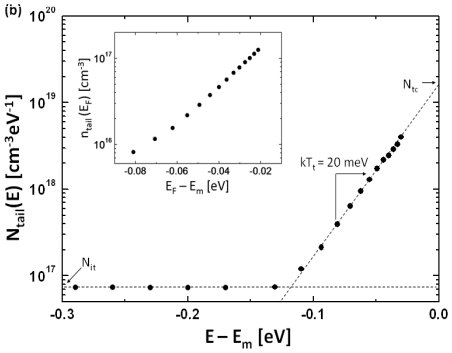
- Illustration of carrier transport at room and low temperatures, respectively:







- Extracted density of tail states:



Conclusion

- Distribution of tail states in energy found to be shallower compared to a conventional material like a-Si.
- Shallow tail states lead to a different temperature dependency and carrier density relations.

Related Publications:

- Sungsik Lee *et al.*, ***Applied Physics Letters*** 101(11), 113502 (2012).
- Sungsik Lee *et al.*, ***IEEE Electron Device Letters*** 33(7), 1006 (2012).