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Analysis of the trap density of states and its effect on the charge transport in *n*-channel organic field-effect transistors

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The trap density of states (trap DOS) in *n*-channel organic field-effect transistors (OFETs) is determined, and trap-limited charge transport is studied by a simulation method based on the assumption of exponential trap DOS. *N*-channel OFETs using *N,N'*-bis(cyclohexyl) naphthalene diimide (Cy-NDI) were fabricated on OTS-treated SiO_2 substrate, and the trap DOS was calculated by the variable temperature analysis (Fig.1(a)) [1]. We supposed the exponential distribution of the trap DOS ($N(E) = N_G \exp[(E - E_C)/kT_G]$) (Fig.1(b)) [2], and conducted computer simulation to investigate the effect of the exponential trap DOS on transistor performance. Simulated transfer characteristics are similar to the experimental characteristics, and calculated threshold voltage shift at low temperatures is consistent with the experimental shift (Fig.1(c)). Additionally, we further analyzed the simulated charge transport by determining the trap DOS from the simulated transfer characteristics (Fig.1(d)), and comparing it with the experimental trap DOS. It reveals that the assumption of the exponential trap DOS successfully demonstrates the device performance of the *n*-channel OFETs using Cy-NDI. Furthermore, the trap-limited charge transport in general *n*-channel OFETs at low temperature is discussed with the simulation method, especially in terms of the width of trap distribution and the total number of trapped charge.

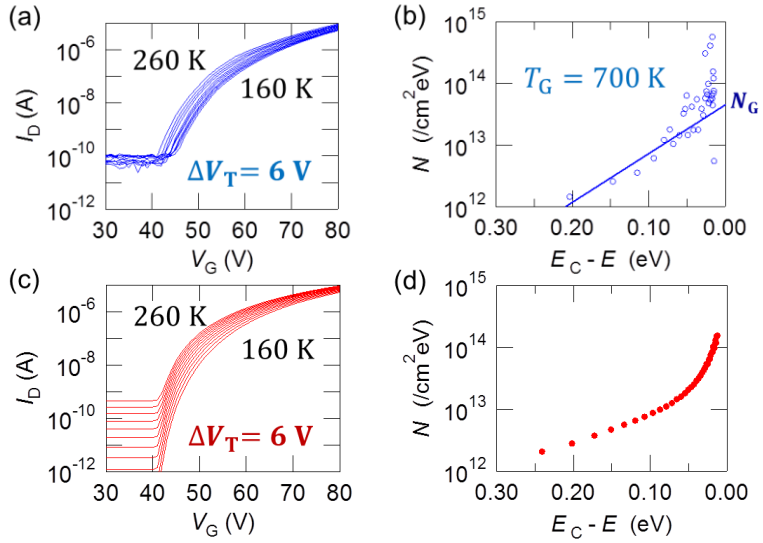

Figure 1. (a) Transfer characteristics of *n*-channel OFETs using Cy-NDI at various temperatures. (b) Trap density of states as deduced from the transfer curves and the assumption of exponential trap DOS. (c) Simulated transfer characteristics. (d) Trap density of states as calculated from the simulated transfer curves.

[1] D. V. Lang *et al.*, *Phys. Rev. Lett.* **93**, 086802 (2004).

[2] G. Fortunato *et al.*, *J. Appl. Phys.* **68**, 2463 (1990).