Field-dependent Effective Transport Energy in Organic Semiconductors

Ling Li, Gregor Meller, and Hans Kosina

Institute for Microelectronics, TU-Wien, Gusshausstrasse 27-29/E360, A-1040, Wien, Austria

Transport energy (1) is a useful tool for the analysis of hopping charge transport in disordered organic materials. Importance of the transport energy stems from the fact that this energy maximizes the probability for a carrier to hop upward; It does not depend on the carrier initial energy, thus serving as an analog of the mobility edge. Although the concept of transport energy has successfully been applied to describe the temperature dependence of the conductivity of organic semiconductors (2), it is difficult to reproduce the experimentally observed electric field dependence. In this work, we present an analytical model for the electric field dependent transport energy. This model can describe the dependence of the transport energy on both temperature and electric field.

In this model, we assume that the localized states of an organic system are distributed randomly both in energy and space, and that the transport between these localized states is due to hopping. The hopping rate between any two sites is a function of temperature, energies of the two sites, and the electric field strength. Assuming a Gaussian density of states (DOS) function and variable range hopping (VRH) theory, we derive a model and use it to study the electronic transport in organic semiconductors. The electric field dependence of transport energy is plotted in Fig. 1. The effect of the electric field on the transport energy is non-monotonic. The relation between mobility and electric field is illustrated in Fig. 2. The mobility increases with electric field in the low field regime, and decreases when the electric field is very high.

(1) V. I. Arkhipov et al., *Synthetic Metals* 2003, Vol **138**, P209
(2) S. D. Baranovskii, P. Thomes, and G. J. Adriaenssen, *Journal.Non-Crystal* 1995, Vol **190**, P283

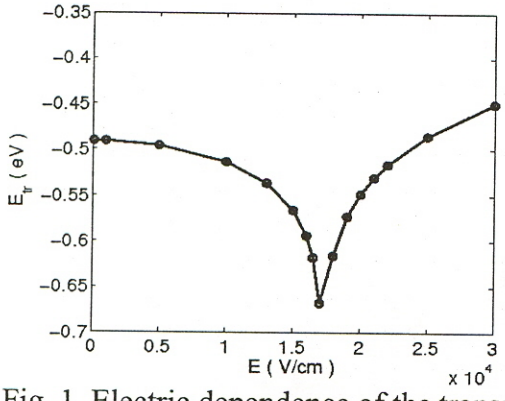

Fig. 1. Electric dependence of the transport energy in organic semiconductors .

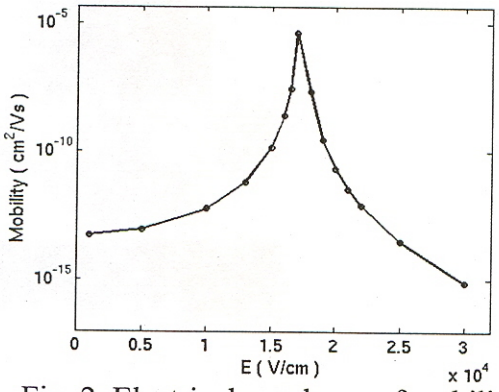

Fig. 2. Electric dependence of mobility in organic semiconductors