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Resolving authentic time dependence of time-of-flight photocurrent in organic semiconductors

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Time-of-flight photoconductivity (TOF) is a powerful method, which is used to study conversion of photons to electrons and their transport through thin organic semiconductor layers. Compared to current-voltage characterization methods, TOF results are unaffected by the spurious effects at the semiconductor/metal interfaces. Precise knowledge of photocurrent time-dependence is of crucial importance for the determination of charge transport parameters such as mobility and the width of charge transporting states. Our TOF measurements of single-crystals of dioctyl-benzothieno-benzothiophene (C8-BTBT) show that transport of photexcited carriers and the corresponding photocurrent across two coplanar metal contacts separated by 120 μm, occurs in a fraction of a microsecond. However, measured time-dependent photocurrent (I(t)), compared to theoretical predictions, showed additional peaks and significant broadening of the I(t) lineshape. We found that additional peaks correspond to signal reflections from the waveguide terminations. And peaks broadening occurs due to 3-ns duration of the photoexcitation laser. Direct deconvolution of the measured signal was not possible due to signal reflections and relatively high noise-to-signal ratio. Therefore we estimated a time dependence of the photocurrent, which reproduced the measured signal transient. Estimated I(t) was considered as an authentic TOF response of the material under investigation.

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