

NREL Determines Long-Lived Carriers and Differences in CdTe Superstrate and Substrate Cells

NREL study may provide future guidance in improving CdS/CdTe photovoltaic device performance.

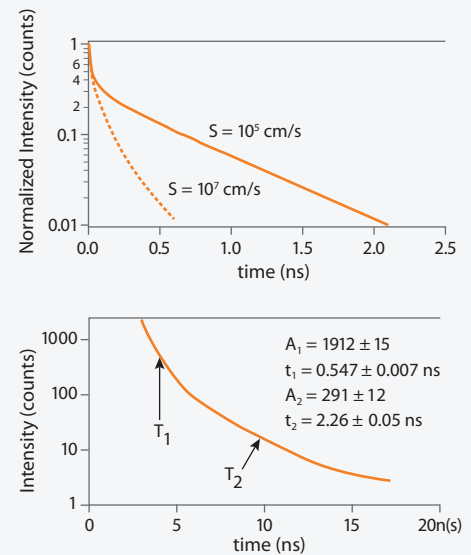
The majority of minority carrier lifetime (MCL) studies performed on CdS/CdTe photovoltaic (PV) devices have correlated device performance primarily with the fast decay observed in time-resolved photoluminescence (TRPL) measurements (t_1). This decay is believed to be associated primarily with recombination in depletion width (W_D), and therefore should be a good indicator of device quality if carrier generation occurs primarily within W_D . However, although previous studies have shown that t_1 can be a good indicator of broad device quality, it does not correlate as well with small changes in device performance and/or with differences observed between superstrate and substrate devices.

Researchers at the National Renewable Energy Laboratory (NREL) have shown that in this case, the parameter t_2 (from the longer-term decay of TRPL) may not only provide a better correlation with device open-circuit voltage (V_{OC}) for superstrate devices but may also provide guidance for inter-comparison with alternative device designs (e.g., substrate devices). It is also suggested that previous studies may yield added value if a larger number of TRPL parameters (i.e., t_1 , t_2 , and respective amplitudes) are re-examined as a function of device performance.

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References: Gessert, T.A.; Dhere, R.G.; Duenow, J.N.; Kuciacuskas, D.; Kanevce, A.; Bergeson, J.D. (2011). "Comparison of Minority Carrier Lifetime Measurements in Superstrate and Substrate CdTe PV Devices." Proc. 37th IEEE Photovoltaic Specialists Conference, 19–24 June 2011, Seattle, WA.

Kanevce, A.; Gessert, T.A. (2011). "Optimizing CdTe Solar Cell Performance: Impact of Variations in Minority-Carrier Lifetime and Carrier Density Profile." *IEEE Journal of Photovoltaics* 1(1), pp. 99–103.



Top: Representative TRPL data for a CdS/CdTe substrate device indicating luminescent decay in the drift-dominated region of the device (t_1) and the region believed to be more dominated by bulk and interface recombination (t_2).

Bottom: Modeled results showing the effect of normalized luminescent decay on surface/interface recombination velocity for a bulk MCL of 1 ns.

Key Research Results

Achievement

NREL found that changes in CdS/CdTe PV device performance may correlate better with t_2 than t_1 .

Key Result

The parameter t_2 may not only provide a better correlation with device V_{OC} for superstrate devices but may also provide guidance for inter-comparison with alternative device designs (e.g., substrate devices).

Potential Impact

This technique may provide future guidance to improve CdS/CdTe device performance.