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Giant polarization in organic heterostructures

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Deep levels or polarization effects can influence the charge transport through organic layers. Both effects can be identified by charge deep-level transient spectroscopy (Q -DLTS). Here, deep levels or polarization effects cause the charge transient signal $Q(t)$ to be dependent or independent on the bias voltage, respectively. Q -DLTS, accompanied by feedback charge capacitance (FCM) measurements, has been used in the present work to investigate an organic heterostructure grown on an inorganic semiconductor. GaAs(100) substrates ($n = 0.34 \times 10^{18} \text{ cm}^{-3}$) were sulfur passivated by wet chemical etching and additional annealing under ultrahigh vacuum (UHV) conditions. Organic molecular beam deposition was used for the growth of 20 nm of 3,4,9,10-perylenetetracarboxylic dianhydride (PTCDA, Lancaster) and 27 nm of *tris*-(8-hydroxyquinoline) aluminum (Alq3, Syntec). Silver was evaporated on the Alq3 film through a shadow mask resulting in an array of circular contacts with an area of $A = 2.1 \times 10^{-7} \text{ m}^2$. The back contact to the GaAs(100) was achieved by an In-Ga alloy resulting in a series resistance of 20 Ω . The electrical characterizations were done at room temperature and *in situ* in the UHV system. The Q -DLTS measurements show a well resolved maximum in $Q(t)$. The amplitude remains almost constant as a function of the bias voltage, which is a clear indication of a polarization in the organic heterostructure. From the experimental results the permittivity dispersion is determined to 2.37. The permittivity dispersion is independently obtained from FCM measurements. With the experimentally determined excess capacitance ΔC of 90 pF and the thickness of the organic heterostructure the permittivity dispersion is determined to 2.42. The FCM scans show no hysteresis due to the absence of deep levels. The $\Delta C/C = 1$ presented here clearly indicates the presence of a giant polarization. ©2002 American Vacuum Society.

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