Effects of Bias cooling and illumination on undoped GaAs/AlGaAs Heterostructures

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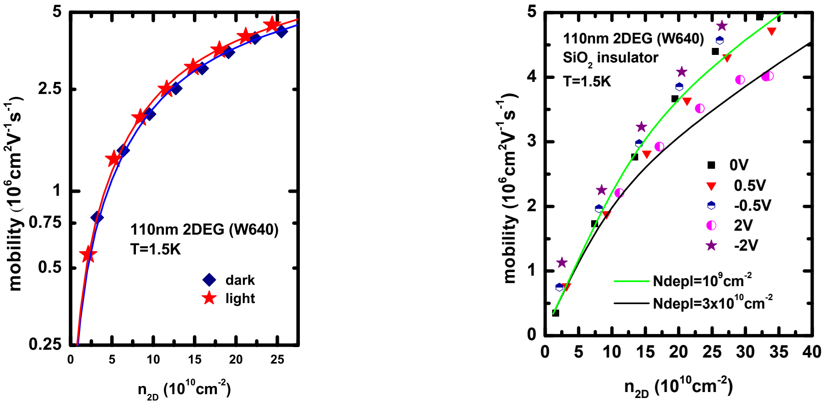
Bias cooling and illumination are two common techniques used in experiments on semiconductor devices. Bias cooling can reduce random telegraph signals (charge noise) in mesoscopic devices whereas illumination is generally used to increase carrier density. Extensive studies (e.g.[1, 2, 3]) have been carried out of these two techniques in doped GaAs/AlGaAs heterostructures. However, with the exception of [4], there has been no reported studies of bias cooling and illumination on undoped devices [5, 6] .

To investigate this, bias cooling and illumination was carried out on a set of 2D samples made on three undoped GaAs/AlGaAs heterostructures where the 2DEG was 60nm, 110nm, and 160nm below the surface. In the illumination experiment, there is a slight improvement in the density-mobility relation in the samples after illumination with a red LED at 10mA (data points). This can be modelled (solid lines) by a decrease in the ionised background impurity level, and is in agreement with [4]. In the bias cooling experiment, the density-mobility relation was mostly unaffected (data points). However, for certain combinations of voltages and insulators, mobility could be decreased or increased. It is possible to model (solid lines) the change in the density-mobility relation by only varying the term corresponding to the overall tilt of the bandstructure in the crystal (N_{depl}).



(a) (b)

Figure 1: Effects of (a) illumination and (b) bias cooldown on the density-mobility relation of 110nm deep undoped 2DEGs.

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