Surface Recombination in Sb-based Infrared Detectors Obtained by Release and Trasfer of Membranes.

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We have recently isolated Sb-based T2SLs in the form of free-standing membranes. The tremendous potential of these new structural elements has been demonstrated through fabrication and characterization of infrared (IR) detectors on T2SLs transferred to Si substrates. Here we investigate the effect of surface recombination on the dark current density of IR detectors obtained by release and transfer of membranes. Specifically, we perform a theoretical and experimental study to isolate the contribution of rough sidewalls on the device characteristics.

For this purpose we fabricate and characterize IR detectors on InAs/GaSb T2SLs transferred to bulk Si using two different techniques. Briefly, a 1.6 μm p-i-n T2SL is epitaxially grown onto a 60 nm $Al_{0.4}Ga_{0.6}Sb$ sacrificial layers on a GaSb substrate. Upon selective removal of the $Al_{0.4}Ga_{0.6}Sb$ layer *via* chemical etching, the 25 × 25 μm^2 membrane becomes freestanding, and it can be transferred to the alternative host. In one case, both the top surface and the sidewalls of the membrane are coated with a hard-baked polymer film (*i.e.*, photoresist), and therefore they are unexposed to the chemical etchant. Scanning electron microscopy of the membrane bonded to bulk Si shows that the structure of the T2SL is not altered during release. In the other case, the photoresist is isolating only the top surface of the T2SL, thereby resulting in a significant roughening of the sidewalls. The poor selectivity of the etching solution between GaSb and the $Al_{0.4}Ga_{0.6}Sb$ sacrificial layer is responsible of this structural change in the transferred membrane. Rough sidewalls are expected to enhance surface recombination in the T2SL and therefore increase the dark current density of an IR detector. We quantify this effect by characterizing IR detectors fabricated on the two mesas. A comparative analysis of the dark current density measured for the two devices signify the effect of having exposed sidewalls during membrane release. These experimental results are consistent with theoretical calculations which show a relative enhancement of surface recombination at increasing roughness of the membrane sidewalls.

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