Electrostatics of atomically thin lateral heterojunctions

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The increasing technological control of two-dimensional materials has allowed the demonstration of 2D lateral junctions, which display unique properties that might serve as the basis for a new generation of 2D electronic and optoelectronic devices. Here we report the investigation of 2D lateral junction electrostatics, which differs from the bulk case because of the weaker screening, producing a much longer transition region between the space charge region and the quasi-neutral region, making inappropriate the use of the complete-depletion approximation[1-3]. For such a purpose we have developed a method based on the conformal mapping technique to solve the 2D electrostatics, which is widely applicable to any kind of junctions, giving accurate results for even large asymmetric charge distribution scenarios. The technique provides a suitable tool to investigate the depletion width, the electrostatic potential, electric field, and surface charge carrier distribution in dependence on the chemical doping densities and dielectric constant of the surrounding environment (see Fig. 1). The proposed technique could be helpful for 2D lateral junctions design and as a benchmarking for further compact model development.

References

[1] H. Yu, A. Kutana, and B. I. Yakobson, Nano Lett. 16, 5032 (2016).

[2] S. Achoyan, A. Yesayan, E. Kazaryan, and S. Petrosyan, Semiconductors 36, 903 (2002).

[3] A. Nipane, S. Jayanti, A. Borah, and J. T. Teheran, J. Appli. Phys. 122, 194501 (2017)

Figures

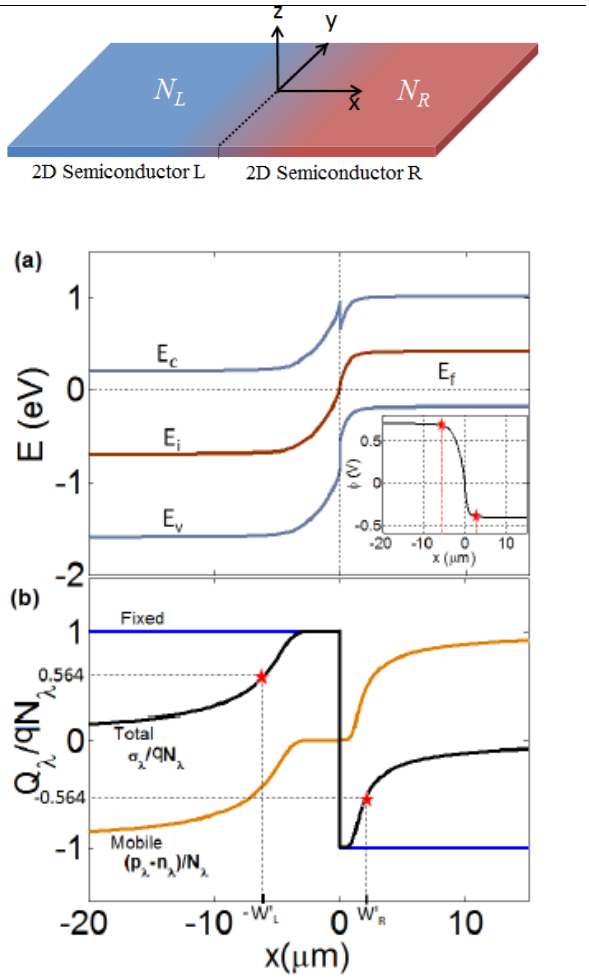

Figure 1: (Top image) Sketch of the 2D junction considered in this work. (Bottom image) Electrostatics of an exemplary 2D lateral Np heterojunction. (a) Energy bands and electrostatic potential (Inset); (b) Surface charge density relative to the fixed charge at both sides of the junction. Red stars in (b) and inset of (a) indicate the relative charge and electrostatic potential at the edge of the depletion widths, respectively.

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