Paweł Dłużewski,
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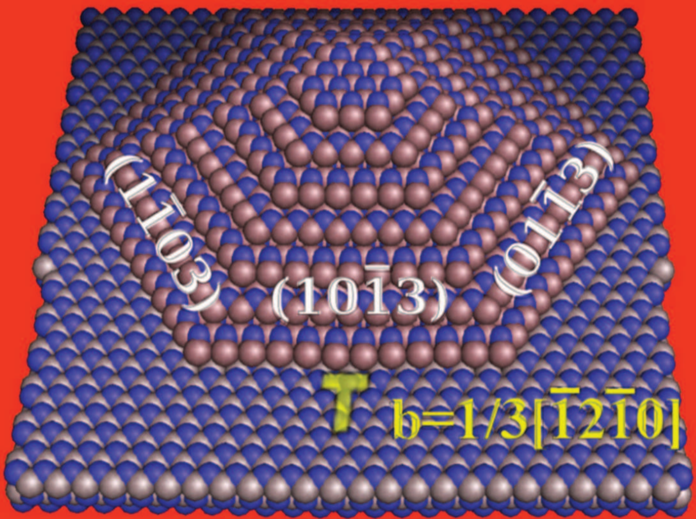
(editors)



Book of abstracts

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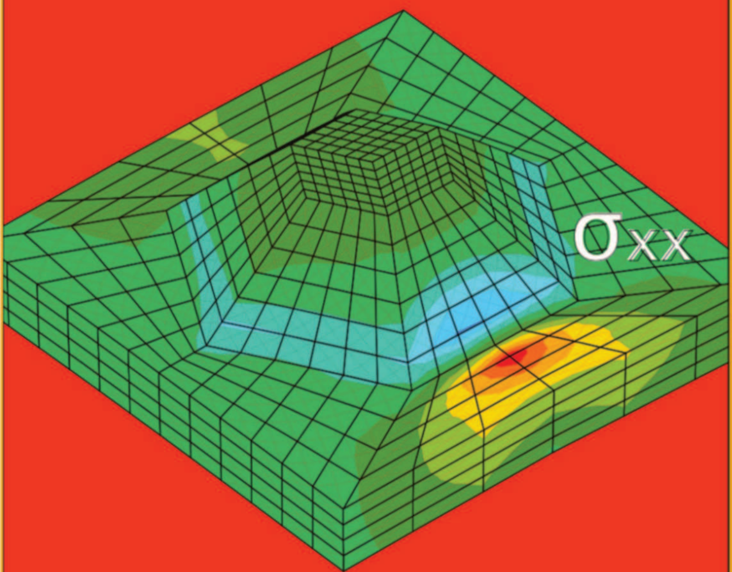

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Effect of threading dislocation on elastic and electric properties of semipolar GaN/AlN quantum dot

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It is observed by experiment [4] that most of wurzite polar GaN quantum dots (QDs) embedded in a AlN matrix are located next to the threading dislocations (TD). It is assumed that local distortion field around dislocation influences the lattice parameters of the crystal structure and provides preferential geometric conditions for the nucleation of the QD at this site. So, on the one hand the presence of dislocations may facilitate QD growth, but on the other hand they play a highly negative role as a non-radiative recombination centres that reduce optical output, heat-up the device and reduce its operational lifetime. Except that, the presence of a long-range elastic and electric fields appearing in the proximity of a negatively charged TD [1] leads to the expectation that these fields will affect elastic, electric and finally an optoelectronic properties of the QD. Therefore, the effect of neigbouring dislocation seems to be very important for the electric properties of the semipolar QD due to the fact that semipolar growth is used to reduce a strong built-in electric field present in QD grown along polar direction. The quantification of that effects remains an open question.

To investigate that phenomena, a model of isolated, rectangular-based $(11\bar{2}2)$ GaN/AlN QD [3] nucleated at the edge of a TD is considered. Burgers vector of a partial Frank-Schockley dislocation, common in a $(11\bar{2}2)$ semipolar heterostructure, is assumed as: $\frac{1}{6}\langle 20\bar{2}3\rangle$ [2]. A boundary-value problem for piezoelectric materialby was solved by use of finite element analysis and elastic, electric and optoelectronic properties (stress, strain, potential, and band edge structure) of the complex system (QD next to TD) were determined. Local elongation of the crystal structure around TD modifies intrinsic compressive stress/strain field present in the quantum dot. Axisymmetric distribution of the negative potential causes shift of the QD build-in electrostatic potential towards negative values. That causes heavy shift of the carriers opposite to the dislocation line. According to a tentative results a TD located next to a semi-polar QD increase intrinsic electric field intensity in QD thererfore has negative effect on the optoelectronic properties of a dot.

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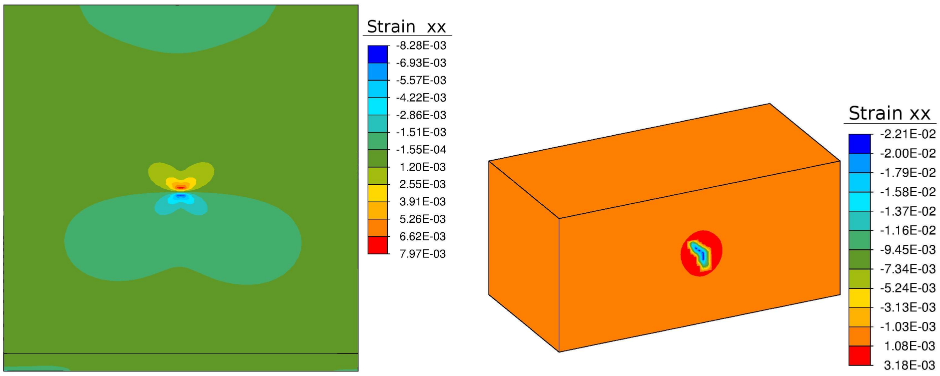

Figure 1: Strain field (xx component) around TD line and intrinsic strain in QD.

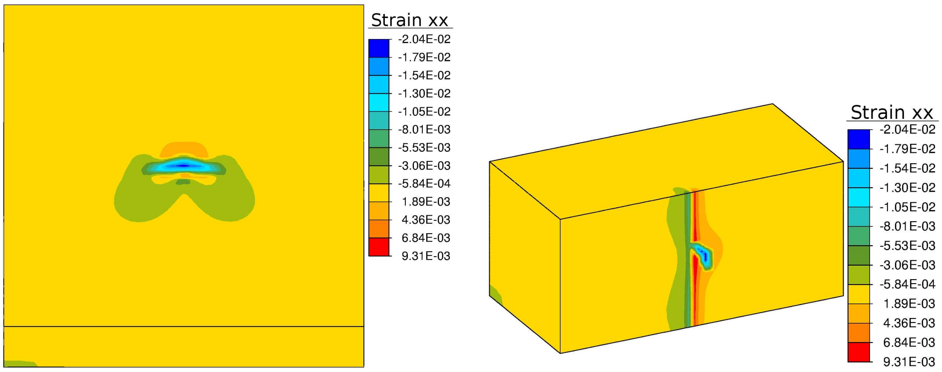

Figure 2: Strain field (xx component) of the system composed of QD grown next to TD.

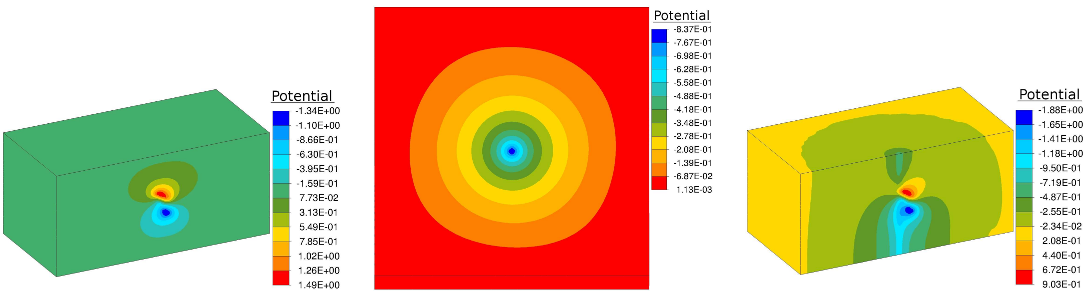

Figure 3: Electrostatic potential field in an isolated QD, around TD, and resultant potential in the sample containing QD and TD.