Transmission electron microscopy and luminescence studies of quantum well structures resulting from stacking fault formation in 4H-SiC layers

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The formation of 3C-SiC staking fault inclusions in higher band-gap other SiC polytypes provides a unique possibility to obtain quantum well (QW) structures without changing of chemical composition of epitaxial layers during growth. [1]

In this report we present low temperature microphotoluminescence and transmission electron microscopy (TEM) studies of 3C-SiC stacking faults inclusions in 4H-SiC homoepitaxial layers, grown by molecular vapor deposition (MOCVD) on 4H-SiC substrates with an 8º surface miscut from the basal plane.

TEM investigations showed that basal plane inclusion with cubic 3C- SiC stacking faults present in the substrate propagate into the 4H-SiC layer material, forming inclined QW structures. The distance between SF was found to vary from 2 nm to 1.5 µm depending on the position on the layer. The presence of SF in the layer was confirmed by photoluminescence studies. They showed that in addition to excitonic emission typical for high quality 4H-SiC layers, well defined group of several emission lines around energy of 2.9 eV, which we attribute to QW formation induced by 3C-SiC staking faults [2]. In contrary to the emission due to nitrogen-bound excitons (observed at higher energy), which remains practically unchanged when changing position on the sample, the energy of spectral lines related to SF emission shows quasi-periodic jumps between well defined values when scanning on the sample surface (laser spot on the sample is of about 1-2 µm). The observed intensity pattern changes in a similar way. The obtained experimental data are discussed in terms of single, double and multiple quantum wells formed form neighboring 3C-SiC SF layers. It is confirmed that a concept of “structure-only” QW is promising from the point of view applications, provided precise control of FS formation during the growth of SiC based nanostructures is attainable. Our results show that, at least the formation of SF related QW structures can be successfully initiated by appropriate substrate preparation.

The research reported in this study was financed by Ministry of Science and Higher Education grants N 507 138 32/4046 and G 007/T02/2007 realized in the years 2007-2009.

The authors thank the Faculty of Materials Science and Engineering of Warsaw University of Technology for permission to use transmission electron microscope JEOL JEM3010.