Physics and Applications of Group III-nitride Semiconductors

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The successful use of the Group III-nitrides (GaN-InN-AlN and their alloys) in manifold optical and electric applications has stimulated wide range of research on this semiconductor family. Selected results of these efforts will be discussed in this presentation.

In the first part of the talk I will concentrate on the physical properties of the wurtzite nitride quantum structures making them different from the better known cubic III-V semiconductors. In particular, I will introduce effects caused by large built-in electric field and In-fluctuations characteristic for In-containing quantum structures. Consequences of polarization charges present at interfaces between different nitrides will be discussed and importance of resulting Quantum Confined Stark Effect for optical properties will be given. Some methods of manipulations leading to reduction of the internal electric field (e.g., use of nonpolar and semipolar structures) will be presented. Moreover, interesting effects of intrasubband transitions will be mentioned also.

On the other hand, highly promising electrical properties of nitrides, including high mobility/high concentration of two dimensional electron/hole gas formed spontaneously at GaN/AlGaN heterostructures will be illustrated.

In the second part of the talk a few examples of applications of nitride quantum structures will be given. I will concentrate on recent achievements and challenges in the field of light emitters: blue and green LEDs and LDs, as well as SuperLuminescent Diodes (SLDs).