Ultraviolet Photoluminescence of Hexagonal Boron Nitride

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Boron nitride is last compound in III-nitride family that becomes researched as semiconductor. It is wide band gap semiconductor of about 6 eV energy gap. Three crystal structures are possible: cubic, wurtzite and hexagonal (graphite-like) h-BN. The latter is the most stable and most promising for application. Some successful structures built of graphen and h-BN were already reported. There are still many discrepancies in reports on photoluminescence (PL) spectra of h-BN. The excitonic emission was reported from 4.1 to 6.5 eV, so some basic measurements are still necessary.

We have grown boron nitride layers on sapphire substrates using MOVPE equipment originally designed for growth of GaN. Moreover we have measured some industrial grade samples (in form of powder and flakes) for comparison.

The photoluminescence was excited with 215 nm (5.8 eV) laser line generated as fourth harmonic of Ti:Sapphire laser working at 860 nm. Two BBO crystals were used for twofold and then fourfold multiplication of the light frequency. Mirror objective was used for micro-PL spectroscopy. Time-resolved PL (TRPL) was measured with a streak camera with quartz optics. Excitation photon energy was below bangap but in resonance with lines reported either as free excitons or as donor-bound excitons (DX). PL spectra recorded in UV range are plotted in Fig. 1. In the near band-gap region a donor-acceptor (or DX) emission at 5.3 - 5.4 eV was observed (in addition to resonant emission at about 5.7 - 5.8 eV). Moreover, some sharp lines at range of 300 nm (4 eV) were measured. The 5.7-eV line had lifetime of about 20 ps, what in other materials is characteristic for free excitons. The 5.3 eV line had different lifetimes in different samples from 0.1 ns to 1 ns in MOCVD sample up to about 10 ns in powder sample.

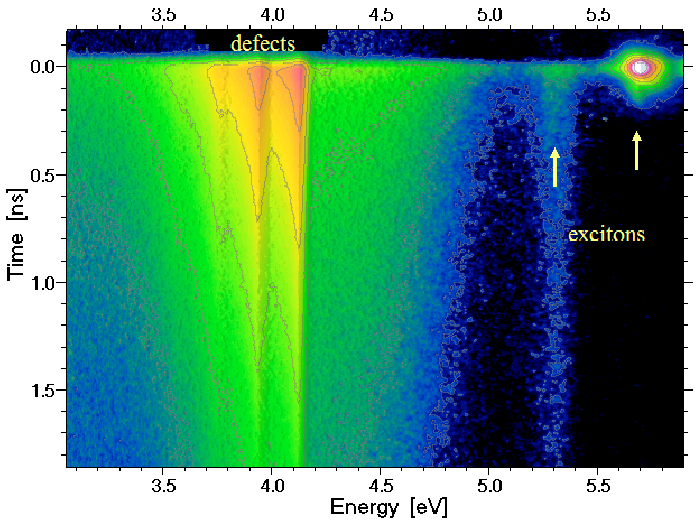

Fig 1. TRPL spectrum of MOCVD sample at 5 K.

The 4-eV band consisted of few sharp lines with nearly identical transients of about 0.7 ns lifetimes. The detailed analysis allows to distinguished two zero-phonon transitions followed by a series of phonon replicas Phonon energy $h\Omega$ = 1490 cm^{-1} can be determined what is significantly higher than 1365 cm^{-1} phonon line observed in Raman spectroscopy. We discuss this discrepancy.