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Krūvininkų gyvavimo trukmė šviesą emituojančiame 6H-SiC, jį taikant šviesos diodams

Carrier Lifetimes in Fluorescent 6H-SiC for LEDs Application

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Recently it was shown a new approach based on all-semiconductor material technology which is composed with a near ultra-violet GaN LED excitation source and fluorescent silicon carbide (f-6H-SiC) substrate which generates a visible broad spectral light by N and B dopants and an efficient donor to acceptor pair recombination [1,2]. This combination can achieve higher electric-light conversion efficiency and high color rendering in comparison with today's used blue GaN LED based and phosphors. The devices are promising candidates for general lightning applications and may obtain stability/reproducibility, and potentially low cost in high performance LEDs. However, there are still many problems to obtain best optimization for f-6H-SiC material since neither carrier transport, nor the carrier recombination is known in such co-doped carbides. From the existing data of carrier lifetimes in the SiC materials it is impossible to calculate requirements for epilayer thicknesses, for surfaces and interfaces that can provide sink for non-intentional losses of emission probability.

In this work we report on carrier lifetime studies in f-6H-SiC epitaxial growth layers that are co-doped by N and B impurities. Epitaxial samples were grown by a sublimation growth process using a control of source materials. Variable concentration of B and N dopants was uniform over epitaxial thicknesses 45-60 µm as was obtained by SIMS measurements (Table 1). Samples had different PL intensity at 300 K. Free-carrier-absorption technique under co-linear and orthogonal probe geometry was used to measure carrier lifetimes in the layers under variable injection conditions. Same results are shown in Fig. 1 exaggerating the fact that longer

Table 1. Dopant concentration and PL intensity at 300K.

Sample No.	B (cm^{-3})	N (cm^{-3})	Comparative PL intensity
ELS 111	8.0×10^{18}	4.0×10^{18}	0.0 %
ELS 115	6.9×10^{18}	3.2×10^{18}	6.6 %
ELS 116	6.9×10^{18}	6.0×10^{18}	8.3 %
ELS 117	4.4×10^{18}	9.0×10^{18}	100.0 %
ELS 118	5.2×10^{18}	9.2×10^{18}	77.1 %

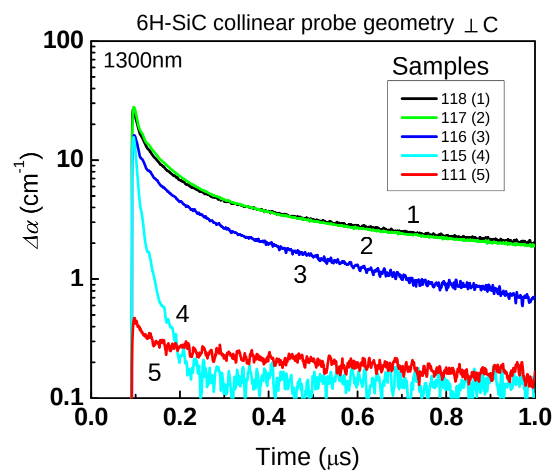

Fig. 1. Induced free carrier transients in different f-6H-SiC epilayers at constant excitation by 355 nm 2 ns laser pulses. Carrier lifetime in the sample 111 (5) is shorter than duration of the laser pulse. This produces a large drop of the induced absorption amplitude.

electron lifetime responsible for higher emission and n-type doping should prevail the p-type doping in active layer of 6H-SiC. An appropriate model for explaining experimental findings will be presented together with an appropriate model for the LED device.

Key words: fluorescent 6H-SiC epilayers, free-carrier-absorption, carrier lifetime decays, dopants, light emitting diode.

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