

STUDY OF OPTICAL AND PHOTOELECTRICAL PROPERTIES OF 3C-SiC SINGLE CRYSTALS AND HETEROSTRUCTURES

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Cubic silicon carbide (3C-SiC) with the energy band gap 2.36 eV ($T=300\text{K}$) possess relatively high electron mobility and appears as promising material for applications in high power and temperature electronics and devices for harsh environment. We review optical techniques able to investigate the optical and photoelectrical properties of SiC at high injection levels. The excess carriers were injected by a short laser pulse and monitored by time-resolved free-carrier absorption (FCA) and light-induced transient grating (LITG) techniques. We also investigated spectra of room-temperature photoluminescence (RTPL), as a complementary technique to reveal defect-related properties. We note that latter technique up to now was mainly used to study low-temperature photoluminescence spectra of SiC.

We investigated thin layers of 3C-SiC, grown by VLS technique and thicker sublimation layers on 6H substrates, as well bulk 3C-SiC crystals grown by chemical vapor deposition on undulant Si. Free standing 3C-SiC layers were obtained after mechanically polishing and chemically etching away the Si substrate. High concentration of defects, e.g., microtwins, dislocations and stacking faults as well unintentional doping by nitrogen impurity is typical for 3C polytype.

Time-resolved FCA kinetics revealed features of linear and nonlinear carrier recombination rates, strongly varying with the growth techniques. Filling of Al or N impurity states by optical pulse and their subsequent thermal recovery rate was studied by differential absorption technique in microsecond time scale. LITG technique provided carrier mobilities in a wide temperature range (10 - 800 K). PL spectra of bulk 3C-SiC revealed edge emission band at 2.28 eV and unexpected broad band at 3.20 eV (above E_g), which might be attributed to the emission from 4H-SiC stacking faults. The properties of both free standing 3C-SiC surfaces were analyzed.

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