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WAVELENGTH-CONVERSION EFFICIENCY ENHANCEMENT IN NANO-TEXTURED FLUORESCENT 6H-SiC PASSIVATED BY ATOMIC LAYER DEPOSITED TITANIUM OXIDE

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In the state-of-the-art technologies, nano-textured surface is an effective approach to boost wavelength-conversion efficiency in fluorescent 6H-SiC based white light-emitting diodes (LEDs) [1]. Surface nanostructures can enhance the light emission in a broad spectral range and omnidirections compared with as-grown 6H-SiC [2]. However, the surface recombination needs to be suppressed to further improve the conversion efficiency. Up to now, still very little work has been reported on surface passivation of fluorescent 6H-SiC. The atomic layer deposited (ALD) TiO2 thin film has been reported to passivate the Si based solar cells [3]. In this work, we investigate the surface passivation effect on nano-textured fluorescent 6H-SiC by (ALD) TiO2 thin films.

Nitrogen and boron co-doped 6H-SiC epilayers (100 μm) were grown on 1.4° off-axis 6H-SiC substrate by the Fast Sublimation Growth Process (FSGP) [4]. Based on the self-assembled nano-patterned reactive-ion etching (RIE) method [5], nano-textured surfaces were fabricated on three samples (a, b, c). Prior to TiO2 film deposition, sample b and c were cleaned by oxygen plasma and dilute HF for 15min and 5min, respectively. A 20nm thick layer was deposited on sample b and c by thermal ALD (Picosun R200). The TiO2 films were synthesized using titanium tetrachloride (TiCl4) and H2O gas as precursors. The deposition was performed at 300°C with a growth rate of 0.4Å per cycle. After TiO2 deposition, sample c was annealed at 500°C for an hour in N2 atmosphere.

Fig. 1. (a) Reflectance and (b) photoluminescence spectra of as-grown sample, sample a (nano-textured), sample b (covered with 20nm thick TiO2) and sample c (covered with 20nm thick TiO2 and annealed at 500°C for 1h).

The reflectance of sample b and c covered with 20nm thick TiO2 slightly decreases compared to sample a, as shown in Fig. 1(a). After deposition of 20nm thick TiO2 layer, the photoluminescence (PL) intensity remains the same. However, the annealed sample c has stronger photoluminescence than the other samples, i.e. the PL has been improved by 8.05% compared to sample b, as shown in Fig. 1(b).

Our experiments show that TiO2 film has an efficient passivation effect on nano-textured fluorescent 6H-SiC after the annealing. The effective passivation is likely to be further improved when the thickness of TiO2, deposition conditions of TiO2 and the annealing conditions.