RESEARCH OF TRANSPARENT ELECTRODE APPLYING TO III-V OPTOELECTRONIC DEVICE

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ABSTRACT

IN THIS THESIS, THE CHARACTERISTICS OF TRANSPARENT ELECTRODE ARE STUDIED. BESIDES, WE USE THE TRANSPARENT ELECTRODE INDIUM-TIN-OXIDE (ITO) ON III-V OPTOELECTRONIC DEVICES TO IMPROVE THE LIGHT EFFICIENCY. THE ITO FILM USED AS THE WINDOW LAYER AND CURRENT SPREADING LAYER ON WAFER-BONDED ALGAINP /MIRROR /SI LIGHT-EMITTING DIODES (MS LEDS) HAS BEEN REPORTED. THE ITO FILMS PREPARED BY SPUTTERING HAVE LOW RESISTIVITY (2.1 ’ 10-4Ω-CM) AND HIGH TRANSMITTANCE (>90% IN THE VISIBLE REGION). THE MS LEDS INCORPORATING THE ITO LAYER AND IN/ITO PROVIDE HIGHER LIGHT OUTPUT THAN NON-ITO MS LEDS. THEY ALSO PRESENT LINEAR INCREASE OF UNIFORM DISTRIBUTED LIGHT OUTPUT WITHOUT RADIATION SATURATION AS THE INJECTION CURRENT INCREASES. MOREOVER, THE MS LED, ITO/MS LED AND ITO/IN/MS LED PROVIDE 2.8, 3.0 AND 3.4 TIMES IMPROVEMENT IN EXTERNAL POWER EFFICIENCY, RESPECTIVELY, AS COMPARED WITH ABSORBING SUBSTRATE LED FABRICATED FROM THE SAME ALGAINP LED WAFER. DUE TO THE IN INSERTING LAYER REDUCING THE CONTACT RESISTANCE BETWEEN ITO AND GAAS CONTACT LAYER WITHOUT CAUSING OBVIOUS ABSORPTION OF THE EMITTING LIGHT, IT MAKES THE ITO/IN/MS LED HAVE THE HIGHEST POWER CONVERSION EFFICIENCY AMONG THESE LEDS. WE ALSO PRESENT A STUDY OF TRANSPARENT INDIUM-TIN-OXIDE (ITO) CONTACT TO N-TYPE AND P-TYPE GAN. ALTHOUGH IT WAS NOT ACHIEVABLE TO MAKE DIRECT OHMIC CONTACT BETWEEN THE ITO AND GAN, THE APPROPRIATE THIN METAL FILM INSERTED INTO THE INTERFACE OF ITO AND GAN CAN ATTAIN AUTHENTIC OHMIC CONTACT. BESIDES, IT ALSO REDUCED THE CONTACT RESISTANCE OBVIOUSLY WITHOUT SACRIFICING THE OPTICAL TRANSMITTANCE. THE IN/ITO (30 NM/250 NM) CONTACT TO N-GAN (1 ’ 1018 CM-3) SHOWS SPECIFIC CONTACT RESISTIVITY OF 6.9 ’ 10-4 W-CM2 WITH TRANSPARENCY FROM 80% TO 95% IN THE VISIBLE REGION AFTER HEAT TREATMENT (600OC). IN ADDITION, THE NI/ITO (10 NM/250 NM) CONTACT TO P-GAN (2 ’ 1017 CM-3) SHOWS LOWEST SPECIFIC CONTACT RESISTIVITY OF 8.6 ’ 10-4 W-CM2 AND HIGH OPTICAL TRANSPARENCY (ABOVE 80% FOR 450 TO 550 NM) AS THE SAMPLE ANNEALED AT 600OC IN AIR. POSSIBLE MECHANISMS FOR THE OBSERVED LOW CONTACT RESISTANCE AND HIGH TRANSPARENCY WILL BE DISCUSSED. THE PRESENNT PROCESS IS COMPATIBLE WITH THE FABRICATION FOR THE HIGH-EFFICIENT GAN LIGHT-EMITTIG DEVICES

Keywords : WAFER BONDING, LIGHT-EMITTING DIODES, ITO, MIRROR SUBSTRATE, WINDOW MATERIAL, CURRENT SPREADING LAYER, OHMIC CONTACT, GAN.

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