

[ZnO-P16]

Highly transparent and low resistance Ni/indium tin oxide(ITO) ohmic contacts to p-type ZnO film

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Recent developments in growth and processing of ZnO-based oxide semiconductor have led to the expectation of optoelectronic devices, such as light emitting diodes (LED), laser diodes (LD), and UV photodetector. ZnO represents an alternate candidate for use in optoelectronic applications in the short wavelength range(green, blue, UV). It was shown that the high contact resistance is one of major obstacles for such devices. Even though it is essential to achieve low resistance and high transparent ohmic contact, low resistance and highly transparent *p*-ZnO ohmic contact has not been achieved yet. In this study, the characteristics of Ni/Indium tin oxide(ITO) ohmic contacts to *p*-type ZnO ($\sim 3 \times 10^{18} \text{ cm}^{-3}$) have been studied. The Ni/ITO(50/500Å) layers were prepared by e-beam evaporation. Although the as-deposited Ni/ITO contact showed high resistance and opaque color, the contact resistance and transparency were significantly reduced significantly and improved, respectively, after thermal annealing process. The contact characteristics of Ni/ITO/*p*-ZnO showed the lowest specific contact resistivity of $6.2 \times 10^{-5} \Omega \cdot \text{cm}^2$ after annealed at 400°C in N₂ atmosphere. In addition, sheet resistance of the contacted metal influences the formation of much linear ohmic contact. AES and XPS analyses were conducted to investigate the extent of interdiffusion and chemical reaction in the interface between Ni/ITO metal and *p*-ZnO film.