

# Structural And Optical Properties Of Nonpolar ZnO Films Grown By Plasma-Assisted Molecular-Beam Epitaxy

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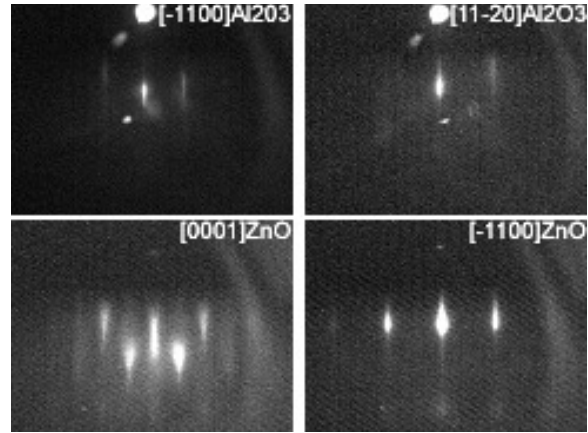
ZnO, as a wide-band-gap semiconductor, has received increasing attention due to its potential applicability to optoelectronic devices such as ultraviolet-light emitting diodes (LEDs) and laser diodes (LDs). Usually, epitaxial ZnO thin films were grown on c-plane Al<sub>2</sub>O<sub>3</sub>, resulting in films with <0001> orientation parallel to the growth direction and has polarization [1]. The polarization induce electric fields along the growth direction resulted in quantum confined Stark effect (QCSE) and poor transition probability, which harmful for light emitting device applications. Therefore, growing ZnO films without polarity along the growth direction, i.e., nonpolar films are needed for future applications of ZnO for light emitting devices.

In this study we have grown non-polar (11-20) ZnO films on R-plane Al<sub>2</sub>O<sub>3</sub> substrates by plasma-assisted molecular-beam epitaxy (PAMBE) and investigated structural and optical properties.

Single crystalline ZnO thin films were grown and epitaxial relationship between the film and substrate was determined as  $[-1101]_{\text{Al}_2\text{O}_3} \parallel [0001]_{\text{ZnO}}$ ,  $[-11-20]_{\text{Al}_2\text{O}_3} \parallel [-1100]_{\text{ZnO}}$  based on the in-situ RHEED analysis and confirmed again by HRXRD measurements. Figure 1 shows RHEED patterns for the sapphire substrate and ZnO film grown for 1 hour,

which indicate single crystalline characteristics and epitaxial relationship. Surface morphology of the films showed facets aligned to the <0001> direction.

Fig. 1 RHEED patterns for the substrate and ZnO film.



Room- and low-temperature photoluminescence spectra showed dominant exciton peaks and the peak positions appeared at higher energy side compared with those for polar ZnO films, which mostly indicating effects of absence of polarization-induced electric field or presence of strains.

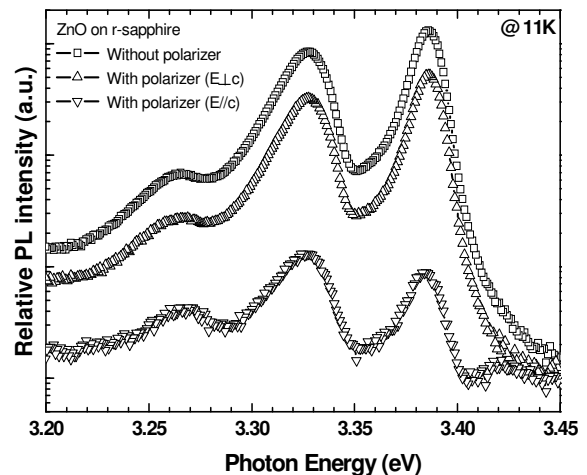


Fig. 2 Polarization dependent photoluminescence from the film.

Figure 2 shows polarization dependent photoluminescence. As shown in Fig. 2, light emission from the nonpolar ZnO films showed strong polarization characteristics and the degree of polarization is much more than 90%, which means that light emitting devices based on nonpolar films are highly promising for the light sources for LCD backlighting.

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[1] S. K. Hong et al., PRB, 65, p. 115331, 2002

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