Effects of oxidized CrN buffer layer on the growth of epitaxial ZnO film on Si(111) by Plasma Assisted Molecular Beam Epitaxy

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Abstract : Epitaxial ZnO film was grown on Si(111) substrate with oxidazed CrN buffer by plasma-assisted molecular beam epitaxy (PAMBE). The growth and structural properties are investigated. The single crystalline growth was revealed by in-situ RHEED analysis. Crystalline quality of ZnO film grown on oxidized CrN buffer was investigated by the X-ray rocking curves. The FWHMs of (0002) XRCs was 1.379°. This value was smaller than the ZnO film grown directly on (111) Si substrate.

Key Words : ZnO, Si, buffer, MBE, epitaxy

1. Introduction

Zinc oxide (ZnO) is a direct wide bandgap semiconductor with a band gap energy of 3.37 eV at room temperature and a very large exciton binding energy of 60 meV[1]. ZnO has attracted much attention for applications in optoelectronic devices, such as light emitting devices (LEDs) and laser diodes (LDs)[2]. For these applications, ZnO film has been grown on various substrates, such as ZnO, Al_2O_3, $MgAl_2O_4$, GaN, and Si. Among these substrates, Si substrate is attractive because it is the cheapest one and large size over 8 inches is available. In addion植狲 愀玲玲爀愀搀玲椀疬wide bandgap wurtzie ZnO 爀愀玲攀 椀猀cubic Si substrate has p爀tential椺狲considering 攀 椀狲well-developed silicon technology椬狲whic愀will open new functional devices.

2. Experimental procedure

Before the ZnO growth, the CrN layer were grown on Si(111) substrate after substrate cleaning process by PAMBE. And then pre-deposited CrN layer were oxidized by using oxygen plasma source with a 1sccm oxygen gas and a RF plasma power of 300W at 500℃. And ZnO films were grown on oxidized CrN buffer and Si(111) substrate respectively.

3. Results and discussion

Figure 1. is the RHEED patterns of the grown samples. In the ZnO pattern, the ZnO grown on oxidized CrN shows the single crystalline feature for the [11-20]ZnO azimuth. but directly grown sample shows mixed RHEED pattern. This means that the ZnO film grown directly on Si(111) is polycrystalline. Figure 2. shows x-ray ω rocking curves (XRCs) for $(0002)_{ZnO}$ reflections, from the single crystalline ZnO film and polycrystalline ZnO film respectively. The Full width at half maximums (FWHMs) for the (0002) XRCs were 1.379° and 4.502°. It means that the CrN and its oxidized layer enhance the crystalline quality of ZnO.

4. Conclusion

In this study, we grow the ZnO films on Si (111) substrate with CrN and its oxidized buffer layers and without buffer layer by plasma-assisted molecular beam epitaxy (PAMBE). When employing the CrN and its oxidation process by oxygen plasma, single crystalline ZnO film was successfully grown. However, without buffer layer polycrystalline ZnO films grown. So the CrN and oxidized layer of CrN enhance the epitaxial growth of ZnO on Si(111) substrate and crystalline quality.

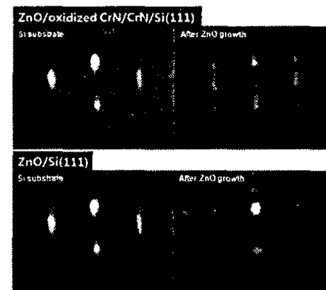

Fig. 1. In-situ RHEED patterns of Si substrates and ZnO films.

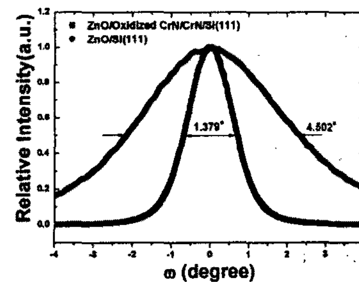

Fig. 2. X-ray ω rocking curves of $(0002)_{ZnO}$ for ZnO films with buffer layer and without buffer layer.

Acknowledgments

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References

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