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RF 마그네트론 스퍼터법으로 성장한 p-i-n LED 구조의 특성평가

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ZnO는 3.37eV의 넓은 에너지 밴드갭을 가지고 있으며,60meV의 큰 엑시톤(exciton) 결합에너지의 특성을 가지고 있어, 최근 ZnO 박막을 이용한 LED및 LD 소자 제작에 대한 연구가 국내외적으로 매우 활발하게 이루어지고 있다. 하지만 ZnO는 산소공공과 같은 결함으로 자발적으로 n-type 특성을 나타내기 때문에 p-type ZnO 합성이 어렵다. 이런 문제점을 해결하기 위해 ZnO와 결정학적 특성이 거의 유사하면서 p-type 형성이 쉬운 GaN를 이용하여 LED 소자를 제작하였다. 또한 p-i-n구조를 이용할 경우 중간층에 삽입된 intrinsic 층에서만 전자 정공 재결합이 일어나기 때문에 발광효율을 향상시킬 수 있다. 본 연구에서는 intrinsic 층위에 n-type ZnO의 캐리어 농도 및 밴드갭변화를 이용하여 발광특성 변화에 대해 연구하였다.

Keywords: ZnO, LED, sputtering, optical property

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Properties of lanthanum oxide deposited by electron cyclotron resonance atomic layer deposition

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As the downsizing tend of MOSFET is continuous, a gate oxide with a thickness of 1nm or less is required for sub-0.1 μm devices. However, scaling down of the SiO2 gate oxide reaches a physical thickness limit. High-k materials such as Al_2O_3, Ta_2O_5, HfO_2, and La_2O_3 have drawn as a great deal of interest as the gate oxide for advanced MOSFET devices. La_2O_3 is one of the promising gate dielectric because of its high dielectric constant, good metal oxide semiconductor capacitor performances, and high crystalline temperature.

In this work, La_2O_3 thin films were deposited by electron cyclotron resonance atomic layer deposition (ECR-ALD). La(i-PrCp)$_3$ (Tris(i-propylcyclopentadienyl)lanthanum) were utilized as the lanthanum precursor. Rapid thermal annealing(RTA) induced dramatic changes in the electrical properties of the La_2O_3 films. We investigated the structural and electrical properties with transmission electron microscopy (TEM), X-ray diffractometer (XRD), and current-voltage(J-V) and capacitance-voltage(C-V) measurements. From I-V measurement of the La_2O_3 films, very low gate oxide leakage currents were observed. The C-V characteristics were analyzed at high frequency (1MHz) with a voltage sweep. The C-V and leakage current measurements were obtained by Agilent B1500A. the EOT was calculated using the CVC program. Crystallity of the films were checked by X-ray diffractometer (XRD). The film thicknesses with respect to the number of ALD cycles and structures were observed using cross–sectional transmission electron microscopy(FETEM, Tecnai F30 S-Twin) images and an ellipsometer(Rudolph AutoEL-II).

Keywords: lanthanum oxide, high-k dielectric, ECR, ALD