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Microstructural Characteristics of III-Nitride Layers Grown on Si(110) Substrate by Molecular Beam Epitaxy

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Nitrides-on-silicon structures are considered to be an excellent candidate for unique design architectures and creating devices for high-power applications. Therefore, a lot of effort has been concentrating on growing high-quality III-nitrides on Si substrates, mostly Si(111) and Si(001) substrates. However, there are several fundamental problems in the growth of nitride compound semiconductors on silicon. First, the large difference in lattice constants and thermal expansion coefficients will lead to misfit dislocation and stress in the epitaxial films. Second, the growth of polar compounds on a non-polar substrate can lead to antiphase domains or other defective structures. Even though the lattice mismatches are reached to 16.9 % to GaN and 19 % to AlN and a number of dislocations are originated, Si(111) has been selected as the substrate for the epitaxial growth of nitrides because it is always favored due to its three-fold symmetry at the surface, which gives a good rotational matching for the six-fold symmetry of the wurtzite structure of nitrides. Also, Si(001) has been used for the growth of nitrides due to a possible integration of nitride devices with silicon technology despite a four-fold symmetry and a surface reconstruction. Moreover, Si(110), one of surface orientations used in the silicon technology, begins to attract attention as a substrate for the epitaxial growth of nitrides due to an interesting interface structure. In this system, the close lattice match along the [-1100]AlN/[001]Si direction promotes the faster growth along a particular crystal orientation. However, there are insufficient until now on the studies for the growth of nitride compound semiconductors on Si(110) substrate from a microstructural point of view. In this work, the microstructural properties of nitride thin layers grown on Si(110) have been characterized using various TEM techniques. The main purpose of this study was to understand the atomic structure and the strain behavior of III-nitrides grown on Si(110) substrate by molecular beam epitaxy (MBE). Insight gained at the microscopic level regarding how thin layer grows at the interface is essential for the growth of high quality thin films for various applications.

Keywords: nitride, thin film, microstructure, Si (110)

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CIGS 박막 태양전지에서의 온도 스트레스에 의한 전기적 특성 및 효율 변화 분석

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CIGS박막 태양전지의 온도에 의한 효율과 전기적 특성 변화를 알아보기 위해 25°C, 50°C, 100°C, 150°C, 200°C에서 각각 100시간을 노출시킨 후 전기적인 특성들을 측정하여 초기 값들과 비교하였다. 태양전지의 온도 스트레스에 의한 특성 및 파라미터들의 변화들을 확인하기 위해 Light I-V와 Minority Carrier의 Lifetime을 측정하여 비교 분석하였다. 실험에 사용한 소자의 초기 파라미터들은 25°C에서 측정하였고, 단락전류 11mA, 개방전압 0.64V, 곡선인자 60.49%, Lifetime 10.7s 효율 9.17%이다. 각 온도별 노출에 대해 CIGS박막 태양전지의 효율은 50°C, 100°C에서는 초기 값과 비슷하였고, 150°C, 200°C에서 초기 값 대비 54%, 84% 감소 특성을 보였다. 단락전류는 50°C, 100°C, 150°C에서는 크게 변화하는 모습이 나타나지 않았고 200°C에서 63% 감소하였다. 개방전압, 곡선인자, Lifetime은 효율과 마찬가지로 150°C, 200°C에서 감소하는 모습이 나타났다. 150°C, 200°C에서 개방전압이 9.3%, 18.7%, 곡선인자는 45.8%, 56.3%정도 감소하였다. Lifetime은 64.4%, 80.1%정도 감소하였다. 이 실험을 통해 개방전압과 곡선인자, Minority Carrier의 Lifetime이 일정 온도부터 온도의 영향을 받아 감소하고, 그 영향으로 효율이 감소하게 되는 것을 확인하였다.

Keywords: 태양전지, CIGS, lifetime, 효율