JOURNAL OF APPLIED PHYSICS VOLUME 96, NUMBER 7 1 OCTOBER 2004

Characteristics of dislocations in ZnO layers grown by plasma-assistedmolecular beam epitaxy under different Zn/O flux ratios

Agus Setiawan*, Zahra Vashaei, Meoung Whan Cho, and Takafumi Yao[a)]
Center for Interdisciplinary Research, Tohoku University, Aramaki, Aoba-ku, Sendai, 980-8578, Japan

Hiroyuki Kato, Michihiro Sano, and Kazuhiro Miyamoto
Research & Development Center, Stanley Electric Co., Ltd., 1-3-1 Eda-Nishi, Aoba-ku, Yokohama 225-0014, Japan

I. Yonenaga
Institute for Materials Research, Tohoku University, 2-1-1 Katahira, Aobaku, Sendai 980-8577, Japan

Hang Ju Ko
Korea Photonics Technology Institute, 459-3 Bonchon-dong, Buk-gu, Gwangju 500-210, South Korea

(Received 24 March 2004; accepted 29 June 2004)

We have investigated the characteristic of the dislocations in the ZnO layers grown on *c* sapphire by the plasma-assisted molecular beam epitaxy under the different Zn/O flux ratios. The ZnO layers were characterized by the transmission electron microscopy (TEM) and the high-resolution x-ray diffraction (HRXRD). The TEM and HRXRD experiments revealed that the major threading dislocations (TDs) in the ZnO layers are the edge dislocations running along the *c* axis with Burgers vector of 1/3k11–20l. The TD densities are determined to be 6.93109, 2.83109, and 2.7 3109 cm−2, for O-rich, stoichiometric, and Zn-rich grown ZnO, respectively. Different from the O-rich grown ZnO where the dislocations run along the *c*-axis, several dislocations in the stoichiometric and the Zn-rich grown ZnO are inclined to 20°,30° from the *c*-axis. By considering the slip system in the wurtzite-structure ZnO, the glide planes of the dislocations are close to s10-10d for the O-rich grown ZnO and close to s10-11d for the stoichiometric and Zn-rich grown ZnO. Furthermore, the thickness of the interface dislocations in the O-rich grown ZnO is much thinner than in the stoichiometric and Zn-rich grown ZnO. In addition, the most probable origin of the inclined dislocations including *c*/*a* ratios, growth rate, and initial growth stage of high temperature sHTd-ZnO layers are also discussed. © *2004 American Institute of Physics*.

[DOI: 10.1063/1.1785852]

Note:
*Permanent address: Department of Mechanical Engineering Education, Indonesia University of Education, Jl. Dr. Setiabudhi 207 Bandung, Indonesia