Effective Mass in Zinc Nitride Thin Films

Chubu Univ. °X. Cao, Y. Ninomiya, A. Sato, N. Yamada

E-mail: jscaoxiang_chubu@isc.chubu.ac.jp

INTRODUCTION: Zn_3N_2 is an *n*-type nitride semiconductor. We reported electrical properties of Zn_3N_2 polycrystalline films which had high mobilities(~85 $cm^2V^{-1}s^{-1}$) [1]. To evaluate Zn_3N_2 as a semiconductor, research on effective mass (m^*) in Zn_3N_2 is still needed.

EXPERIMENTS: Zn_3N_2 films were grown on YSZ(100) heated at 100–250 °C by reactive sputtering technique. The Infrared transmittance (T) and reflectance (R) were measured using a FTIR spectrophotometer. We performed fitting analyses of T and R spectra using the Drude model (Drude fitting) in order to derive m^*.

RESULTS & DISCUSSION: All the films in this study were confirmed to be a degenerate semiconductor possessing n_e on the order of 10^{19} cm^{-3}. As seen in Fig. 1, T and R spectra of Zn_3N_2 epitaxial films clearly exhibited Drude-like behavior. The spectra could be reproduced well by using the Drude model (continuous lines in Fig. 1). In the Drude fitting procedure, plasma frequency (ω_p) and scattering time were used as fitting parameters. We calculated m^* values from ω_p and carrier concentration (n_e). As shown in Fig. 2, m^* increased with an increase in n_e. Such behavior is usually interpreted in terms of non-parabolicity of the conduction band. We adopted a non-parabolic band model proposed by Pisarkiewicz *et al.*[4] to analyze n_e dependence of m^*. The solid line in Fig. 2 presents the best fit

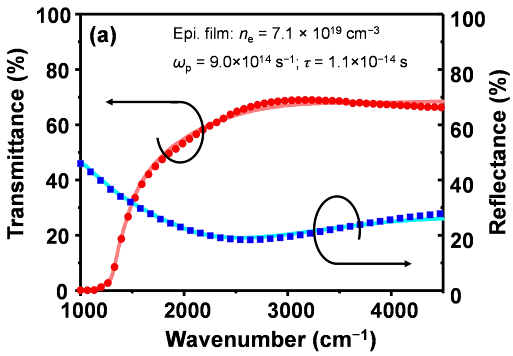

Fig. 1 Infrared transmittance and reflectance for a Zn_3N_2 epitaxial film.

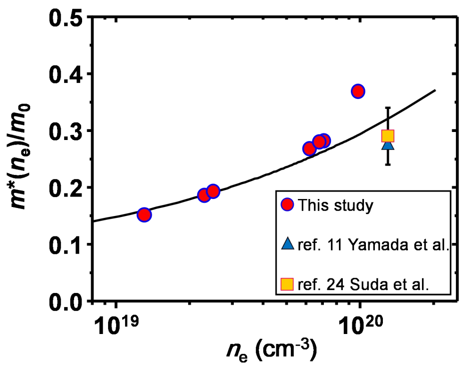

Fig. 2 Effective mass [$m^*(n_e)/m_0$] as a function of carrier concentration n_e. The solid curve represents the best fit obtained at m_0^* = 0.073 m_0.

of the non-parabolic model to the experimental data. From this result, the effective mass at the bottom of the conduction band (m_0^*) was deduced to be m_0^* = 0.073m_0 (m_0 denotes free electron mass). The m_0^* value is as small as those in GaAs and InN. These results suggest that Zn_3N_2 is a very promising as a high mobility semiconductor.

REFERENCES

[1] Cao *et al.*, *J. Phys. Chem. C* **119**, 5327 (2015).
[2] Yamada *et al.*, *Jpn. J. Appl. Phys.* **53**, 05FX01 (2014).
[3] Suda *et al.*, *J. Appl. Phys.* **99**, 076101 (2006).
[4] Pisarkiewicz *et al.*, *Thin Solid Films* **174**, 217 (1989).

© 2015年 応用物理学会