B-P-137

Hole conduction characteristics of cubic $Ti_{1-x}Al_xN$

M. Yoshikawa[1†], D. Toyama[1], T. Fujita[2], N. Nagatomo[2], T. Makimoto[1*]

[1]Waseda Univ., Tokyo, Japan
[2]Mitsubishi Materials Corporation.,Ibaraki, Japan

[*]Corresponding author's e-mail: *makimoto@waseda.jp*

ABSTRACT

A nitride thin film thermistor has some characteristics such as high speed heat response time, lightweight device and flexible nature. Due to these characteristics, it is expected to be widely used compared with the conventional bulk oxide thermistor. The high B value, corresponding to an activation energy of the electrical resistivity, is reported for hexagonal TiAlN with a low Ti composition. [1] In this study, Hall effect measurements were carried out from 10 K to 295 K for cubic $Ti_{1-x}Al_xN$ with a high Ti composition and we will report their electrical conduction characteristics in this conference.

$Ti_{1-x}Al_xN$ (x = 0.5, 0.6) films were deposited using RF (radio frequency) sputtering and AIP (arc ion plating) methods on a thermally oxidized Si substrate to evaluate the temperature dependence of their electrical characteristics.

Each TiAlN showed p-type conduction by the Hall effect measurements. The specific resistance of $Ti_{0.4}Al_{0.6}N$ deposited by the RF sputtering method strongly depends on temperature (T). The hole concentration in each TiAlN in a high temperature range decreases exponentially with the reciprocal temperature (1/T), showing that each TiAlN has deep acceptors. Their activation energies were ranging from 18 meV to 30 meV. The temperature dependence of the hole concentration also shows that the hole conduction in the valence band is dominant in a high temperature range, as is often observed in many semiconductor thin films. In contrast, the conductivity (σ) in each TiAlN obeys the$\sigma=\sigma_0 \exp(-A/T^{1/4})$ relation in a low temperature range. This result is interpreted as variable-range hopping caused by localized states in TiAlN. [2] In these TiAlN films, deep acceptors are consider to act as the localized states, since some of them are not activated in a low temperature range.

Keywords: TiAlN, electrical resistivity, hopping conduction, grain-boundary.

REFERENCES

[1] T. Fujita, H. Tanaka, H. Inaba, and N. Nagatomo, J. Ceram. Soc. Japan, vol. 124, no. 6 pp. 653-658 (2016).
[2] N. F. Mott and E. A. Davis, Electronic Processes in Non-crystalline Materials, 2nd ed. (Clarendon, Oxford, 1979).