Low Temperature AlN Film Growth for the Foreseeable-Future Power Electronics

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1. Objective

This project is aimed at:

Developing a low-temperature-growth method and deposition process for aluminum-nitride (AlN) thin films that are suitable for use in high-electron-mobility transistor (HEMT) devices or power electronics, and clarifying the characteristics and features of the electrical and electronic properties of such AlN thin films and their potential for use in other applications. We have proposed a novel technique using 10-nm-thick Ga-doped ZnO films having a texture with a preferential *c*-axis orientation deposited at a low glass-substrate temperature (< 200 ºC) to achieve a high Hall mobility Al-doped ZnO films (Nanoscale Research Letters, (2016) 11:320 DOI: 10. 1186/s11671-016-1535-1.).

2. Project Outline

To that end, the project will consist of the following phases:

(a) The development/design/creation of low-temperature deposition of AlN-based films
(b) The clarification of a relationship between the orientation distribution of polycrystalline structure and carrier transport
(c) Experimental verification of the possibility of band-gap engineering of AlN for high power electronics

3. Expected Performance

In this project, the successful candidate would be expected to:

(a) Working independently, develop/design/create etc.;
(b) Provide supervision for collaborative research between academia and industry;
(c) Perform routine work in terms of maintenance/set-up/repair/development of film-deposition methods

4. Required Skills and Knowledge

The successful candidate for this project will have the following knowledge and skills:

(a) Basic knowledge of Semiconductors

(b) Film Growth such as sputtering, CVD, Ion-plating

(c) X-ray diffraction measurements and analysis

References

(1) T. Yamamoto and H. Katayama-Yoshida、" Solution Using a Codoping Method to Unipolarity for the Fabrication of *p*-Type ZnO", Jpn. J. Appl. Phys. 38 (1999) L166-L169.

(2) J. J. Kim, H. Makino, K. Kobayashi, Y. Takata, T. Yamamoto, T. Hanada, M. W. Cho, E. Ikenaga, M. Yabashi, D. Miwa, Y. Nishino, K. Tamasaku, T. Ishikawa, S. Shin, and T. Yao "Hybridization of Cr 3*d*N 2*p*Ga4*s* in the wide band-gap diluted magnetic semiconductor $Ga_{1-x}Cr_xN$", Phys. Rev. B70, pp. 161315-1(R)-161315-4 (2004).

(3) T. Yamada, A. Miyake, S. Kishimoto, H. Makino, N. Yamamoto and T. Yamamoto, "Low-resistivity Ga-doped ZnO thin films of less than 100 nm thickness prepared by ion plating with direct current arc discharge", Appl. Phys. Lett. 91 (2007) 051915.

(4) J. Nomoto, H. Makino and T. Yamamoto, "High-Hall-Mobility Al-Doped ZnO Films Having Textured Polycrystalline Structure with a Well-Defined (0001) Orientation", Nanoscale Research Letters (2016) 11:320 DOI: 10. 1186/s11671-016-1535-1.

(5) J. Nomoto, K. Inaba, M. Osada, S. Kobayashi, H. Makino and T. Yamamoto, "Highly (0001)-orientated Al-doped ZnO polycrystalline films on amorphous glass substrates", J. Appl. Phys., 120(2016)125302.

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