

## VI-T Ultraviolet, Visible and Infrared Spectroscopy of Solids

Work of ultraviolet (UV), visible (VIS) and infrared (IR) spectroscopy of solids have been proceeded. These are mainly performed using synchrotron radiation (beamlines BL7B and BL1B at UVSOR), owing to the wide wavelength continuity of synchrotron radiation with no structure.

### VI-T-1 Reconstruction of BL7B for UV, VIS and IR Spectroscopy with a 3 m Normal-Incidence Monochromator

FUKUI, Kazutoshi; NAKAGAWA, Hideyuki<sup>1</sup>; SHIMOYAMA, Iwao<sup>2</sup>; NAKAGAWA, Kazumichi<sup>2</sup>; OKAMURA, Hidekazu<sup>2</sup>; NANBA, Takao<sup>2</sup>; HASUMOTO, Masami; KINOSHITA, Toyohiko<sup>3</sup>  
(<sup>1</sup>Fukui Univ.; <sup>2</sup>Kobe Univ.; <sup>3</sup>Univ. Tokyo)

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The beamline BL7B at the UVSOR facility for solid-state spectroscopy is currently under reconstruction. This reconstruction mainly involves the replacement of the 1 m Seya-Namioka-type monochromator (50-600 nm) with a 3 m NIM (modified version of McPherson model 2253), which covers the 50-1000 nm range with three gratings. The deviation angle of the gratings is 15°. For linear and circular polarization experiments, the beamline optics consist of a two-grazing-incidence (87.5°) pre-mirror system and a normal-incidence (15°) post-mirror.

### VI-T-2 Absorption and Luminescence Spectra of Amorphous CdI<sub>2</sub> Thin Films

FUKUI, Kazutoshi; ASAKURA, Kenji<sup>1</sup>; NIIMI, Ken-ichi<sup>1</sup>; ISHIZUE, Ikuto<sup>1</sup>; NAKAGAWA, Hideyuki<sup>1</sup>  
(<sup>1</sup>Fukui Univ.)

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Absorption and luminescence spectra of amorphous CdI<sub>2</sub> thin film were measured at liquid nitrogen

temperature. Two emission bands were observed at 2.3 and 3.1 eV, and the intensity ratio between them depends on the excitation energy. The 3.1 eV emission is explained in terms of the MX<sub>6</sub> model which explains the emission mechanism of the CdI<sub>2</sub> crystal, but the other is not explained.

### VI-T-3 Optical Study of the Metal-Nonmetal Transition in Ni<sub>1-δ</sub>S

OKAMURA, Hidekazu<sup>1</sup>; NAITOH, Jun<sup>1</sup>; NANBA, Takao<sup>1</sup>; MATOBA, Masanori<sup>2</sup>; NISHIOKA, Masaya<sup>2</sup>; ANZAI, Shunichiro<sup>2</sup>; SHIMOYAMA, Iwao<sup>1</sup>; FUKUI, Kazutoshi; MIURA, Hiroshi<sup>3</sup>; NAKAGAWA, Hideyuki<sup>3</sup>; NAKAGAWA, Kazumichi<sup>1</sup>; KINOSHITA, Toyohiko<sup>4</sup>  
(<sup>1</sup>Kobe Univ.; <sup>2</sup>Keio Univ.; <sup>3</sup>Fukui Univ.; <sup>4</sup>Univ. Tokyo)

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Optical reflectivity spectra of the hexagonal Ni<sub>1-δ</sub>S have been measured to study its electronic structures, in particular those associated with the metal-nonmetal transition in this compound. Samples with δ ~ 0.002 and 0.02 are studied, which have transition temperature T<sub>t</sub> ~ 260 K and 150 K, respectively. Upon the transition, a pronounced dip appears in the infrared region of the reflectivity spectra. The optical conductivity spectra suggest that the nonmetallic phase is a carrier-doped semiconductor with an energy gap of ~ 0.2-0.3 eV. The spectra also show that the gap becomes larger with decreasing temperature, and smaller with increasing δ. It is found that the overall spectrum in the nonmetallic phase can be explained in terms of a charge-transfer semiconductor, consistent with recent theoretical and photoemission studies of NiS.

## VI-U Electronic Structure and Optical Properties of III-V Nitrides

The III-V nitrides (GaN, AlN and InN) and their alloys (AlGaN, InGaN and AlInN) are promising for optoelectronic device application. They are also the attractive material series which have scientific interest because the band structure, the luminescence mechanisms, excitons, *etc.* are still not well known. We mainly investigate their band structures using vacuum ultraviolet and soft X-ray monochromators combined with synchrotron radiation light source (UVSOR). Since the core levels are strictly localized in space, core absorption spectrum gives us the site-specific information which is a useful method to investigate the binary or ternary compounds.

### VI-U-1 Soft X-ray Absorption Study of III-V Nitrides

FUKUI, Kazutoshi; HIRAI, Ryouzuke<sup>1</sup>; YAMAMOTO, Akio<sup>1</sup>; NAOE, Syun-ichi<sup>2</sup>; TANAKA, Satoru<sup>3</sup>  
(<sup>1</sup>Fukui Univ.; <sup>2</sup>Kanazawa Univ.; <sup>3</sup>Hokkaido Univ.)

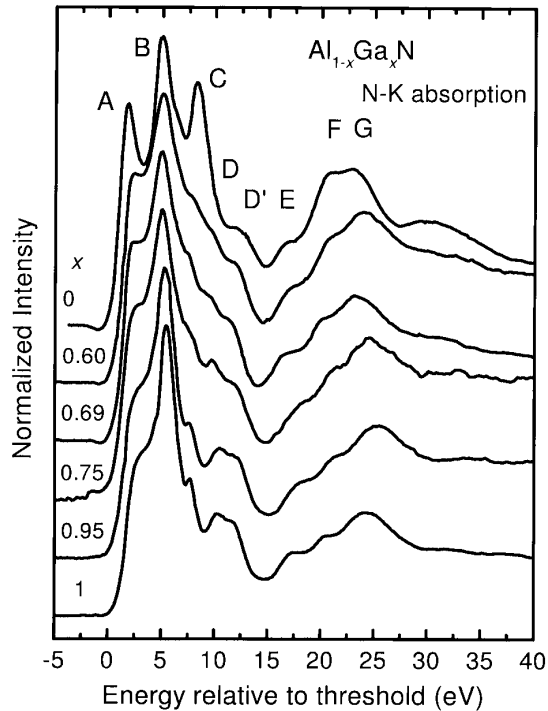
[*Jpn. J. Appl. Phys., Part 1* **38**, 538 (1999)]

The soft X-ray absorption measurements around nitrogen K and aluminum K edge of the wurtzite AlN, GaN and their ternary compounds AlGaN have been performed. The incidence light angle dependence of the absorption spectra were clearly observed in all samples. A numerical component analysis is presented to separate the experimental K-absorption spectra into three partial spectra which correspond to in-plane, out-

of-plane and angular independent components of the unoccupied  $p$  partial density of states.

#### Reference

- 1) W. R. L. Lambrecht, S. N. Rashkeev, B. Segall, K. Lawniczak-Jablanska, T. Suski, E. M. Gullikson, J. H. Underwood, R. C. C. Perera, J. C. Rife, I. Grzegory, S. Porowski and D. K. Wickenden, *Phys. Rev. B* **55**, 2612 (1997).



**Figure 1.** Normal incidence nitrogen K absorption spectra of  $\text{Al}_{1-x}\text{Ga}_x\text{N}$ . The energy scale is relative to the threshold energy. The labels A to G correspond to those for GaN in Reference 1. The intensity of each spectrum is normalized at the peak B.