Structural modulation of carbides and nitrides by X-ray irradiation using synchrotron radiation

Fumio SATO[1*], Nobuo SAITO[1], Yasunori TANAKA[2], Naoto KOBAYASHI[2], Yasushi KAGOSHIMA[3] and Junji MATSUI[3]

[1] NHK Science and Technical Research Laboratories, 1-10-11, Kinuta, Setagaya-ku, Tokyo 157-8510,

[2] Elcrtotechnical Laboratory, 1-1-4, Umezono, Tsukuba, Ibaraki 305-8568,

[3] Himeji Institute of Technology, 1479-1, Kanaji, Kamigori-cho, Ako-gun, Hyogo 678-12.

Wide gap semiconductors such as carbides and nitrides are promising materials for field emitters due to their small or negative electron affinity. However low temperature growth of those crystals having the low threshold voltage for electron emission has not been succeeded. This can be mainly attributed to small diffusivity of atoms in their crystal or amorphous states. In this study, the authors have tried to improve the crystallinity of amorphous aluminum nitride (AlN) and boron nitride (BN) films by X-ray irradiation as the first step to low temperature growth.

Amorphous films were deposited on Si(100) wafers by laser ablation using ArF^+ laser (λ =193nm) and targets of AlN or BN . These specimens were irradiated with White X-rays through Be windows. (white mode operation, undulator gap: 11.3mm, beam current: 60-70mA, irradiation duration: 30min.-3hrs.) Irradiation was performed in vacuum chamber. Temperature increase due to irradiation was less than 300℃. The irradiated area of the specimen was approximately 0.5 x 1 mm^2.

Figure 1 shows the typical infra-red transmittance spectra for the AlN films deposited at 800℃ before and after irradiation. Transmittance increases substantialy by X-ray irradiation, indicating the improvement of the crystallinity. It was confirmed that relatively large improvement was achieved for more defective films as the deposited state. Similar results were obtained for BN films in transmitance spectra. This kind of crystallization has been considered to take place by the rearrangements of atoms through the Coulombic explosion after inner-shell excitation.

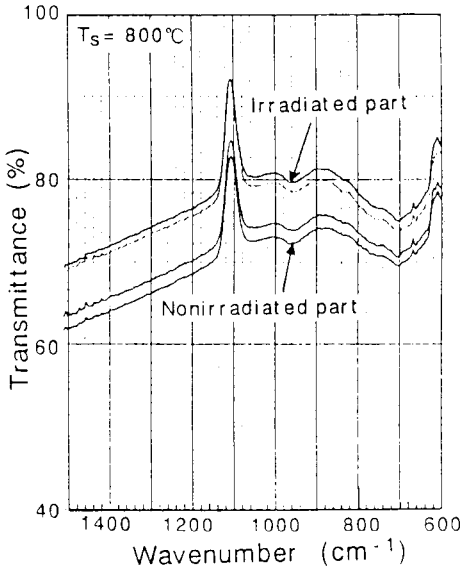

Fig. 1. IR transmittance spectra for AlN films before and after X-ray irradiation.