mode at frequency of 298, 392 and 681 cm\(^{-1}\) emerged after irradiation. The additional modes around 296 and 683 cm\(^{-1}\) were observed at the fluence of \(5 \times 10^{10} \text{ cm}^{-2}\), which is shown in Fig. 3, and they are related to the disorder-activated Raman Scattering (DARS) mechanism\(^{[2]}\). As shown in Fig. 4, the FTIR spectrum showed an absorbance peak at 434 cm\(^{-1}\) disappeared, an absorbance peak at 809 cm\(^{-1}\) low wave number shifted and an absorbance band at 1370 and 1580 cm\(^{-1}\) emerged after irradiation with the fluence of \(5 \times 10^{10} \text{ cm}^{-2}\). The electrical and optical properties of Al\(_{0.25}\)Ga\(_{0.75}\)N have changed when the fluence is \(5 \times 10^{10} \text{ cm}^{-2}\) for 290 MeV U ion irradiation.

References


3 - 23 Electrical and Optical Properties of GaN Epilayer Irradiated with 290 MeV \(^{238}\)U\(^{32+}\) Ions

Gou Jie, Zhang Chonghong, Zhang Liqing, Yang Yitao, Li Jianjian
Sun Youmei and Meng Yancheng

In the present work, Hall measurement, Capacitance voltage measurement (C-V), Micro-Raman scattering techniques and Fourier transform infrared spectra (FTIR) are used to evaluate the electrical and optical properties of GaN epilayer irradiated with 290 MeV \(^{238}\)U\(^{32+}\) ions. N-type GaN films with a thickness about 3 μm were grown on c-plane of a sapphire substrate by MOCVD. Ti/Al/Ni/Au ohmic electrodes were prepared on the GaN epilayer in the Van der Pauw configuration by DC sputtering method and annealed at 650 °C for 55 s at N\(_2\) atmosphere. The Au Schottky electrodes were prepared through DC method on the GaN epilayer to form Schottky diodes. The irradiation with high energy \(^{238}\)U\(^{32+}\) (1.22 MeV/u) ions was performed in a terminal chamber of the sector-focused cyclotron (SFC) in the National Laboratory of Heavy-ion Accelerators in Lanzhou. Fluences of ions were in the range from \(1 \times 10^9\) to \(5 \times 10^{11} \text{ cm}^{-2}\). According to SRIM estimation, the electronic energy loss \(S_e\) of a U ion is 34.7 keV/nm while the nuclear energy loss \(S_n\) of a U ion is 0.292 keV/nm. \(S_e\) is therefore the dominant energy loss mechanism (\(S_e/S_n \approx 119\)). After irradiation, the samples were analyzed by Hall-measurement (operating at room temperature and in the liquid nitrogen temperature, respectively), C-V, Raman and FTIR spectroscopy.
It is found that the trend of the mobility and the carrier density at the room temperature is consistent with the temperature of 77 K, which is shown in Fig. 1 (a). After irradiation, the mobility at 77 K is lower than the mobility at room temperature. This implies that the ionized impurity scattering plays a dominant role after irradiation\(^1\). Carrier density of electrons at room temperature increases and the mobility of the electrons decreases when the fluence of ions reaches \(5 \times 10^{10}\) cm\(^{-2}\). Fig. 1 (b) shows that the resistivity increases sharply also at the fluence of \(5 \times 10^{10}\) cm\(^{-2}\). The carrier density of electrons at 77 K increases and the mobility of the e-electrons decreases when the fluence of ions reaches \(1 \times 10^{9}\) cm\(^{-2}\). The resistivity increases sharply at the fluence of \(5 \times 10^{10}\) cm\(^{-2}\). The capacitance drops sharply at the fluence \(5 \times 10^{10}\) cm\(^{-2}\) and the diffusion barrier height drops after the irradiation, as shown in Figs. 2 and 3. The diffusion potential \(V_{dc}\) is determined from the extrapolation of the linear C\(^{-2}\)-V plot to the V axis. Fig. 4 shows that the Raman spectrum of the \(E_2\) (high) mode at frequency of 569 cm\(^{-1}\) shifts toward high frequency upon irradiation at a fluence of \(5 \times 10^{10}\) cm\(^{-2}\), implying an increase of strain in epilayer\(^2\). Additional modes around 296 and 683 cm\(^{-1}\) are observed at the fluence of \(5 \times 10^{10}\) cm\(^{-2}\), which is shown in Fig. 5, and they are related to the disorder-activated Raman Scattering (DARS) mechanism\(^3\). The FTIR spectrum showed an \(E_1\) (LO) mode emerged at the frequency of 742 cm\(^{-1}\) when the fluence is \(5 \times 10^{10}\) cm\(^{-2}\), as shown in Fig. 6. The electrical and optical properties of GaN change when the fluence reaches \(5 \times 10^{10}\) cm\(^{-2}\).

References