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5 - 13 Ion Irradiation Effects on 4H-SiC Schottky Barrier Diodes

Tian Yinan, Li Ronghua, Li Jian, Li Haixia, Zheng Xuefeng, Cheng Zhaoyi and Sun Jianrong

Semiconductors based on SiC have broad application prospects in particle detectors and power devices due to their excellent performance in extreme environments, such as environments in space exploration or nuclear facilities. 4H-SiC is widely used. It has large forbidden bandwidth (3.2 eV) and high electron mobility (1 200 $cm^2 \cdot V^{-1} \cdot s^{-1}$). Consequently, 4H-SiC Schottky barrier diodes (SBD) are capable of operating under harsh conditions with high temperatures and high levels of radiation. This new generation of particle detectors holds great potential[1].

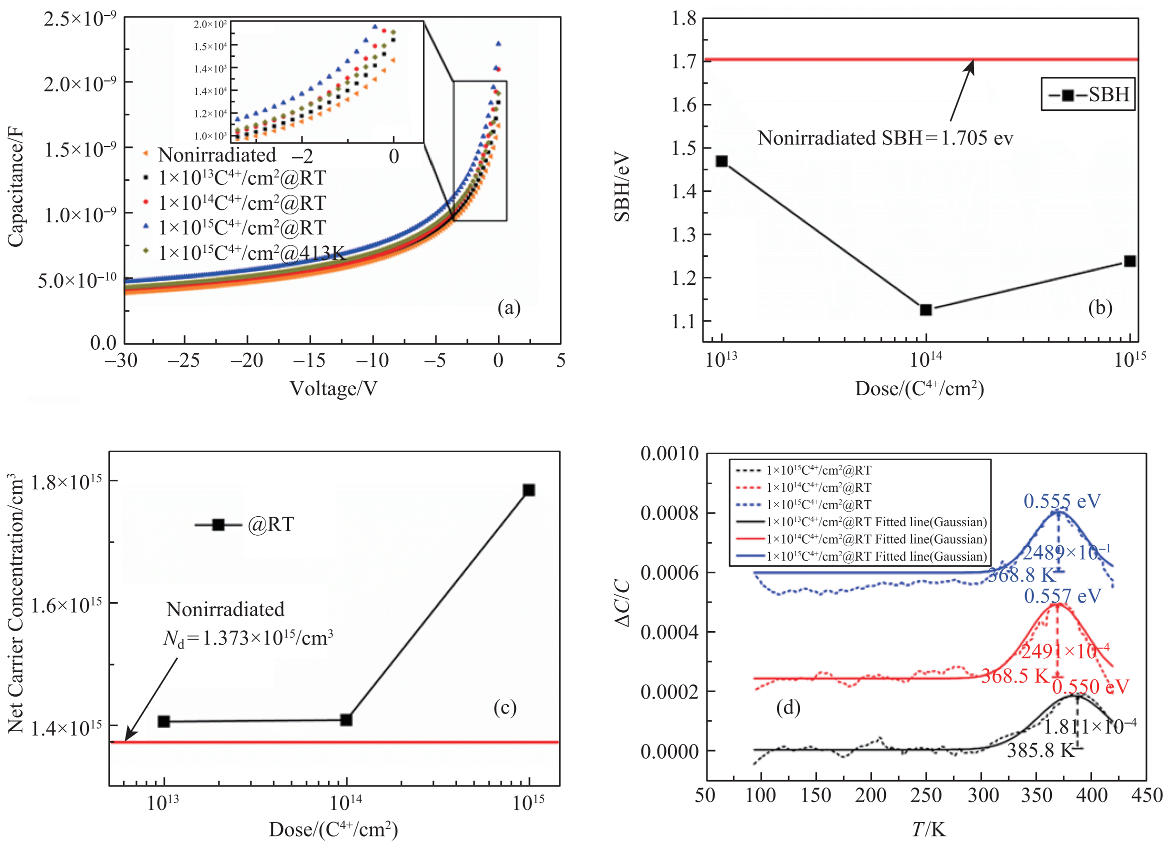

Fig. 1 (color online) (a) *C-V* characteristics at different fluence, (b) SBH at different fluence, (c) Net carrier concentration at different fluence, and (d) Reverse *I-V* characteristic curve.

In this report, Ni/4H-SiC SBDs were irradiated with 280 keV C^{4+} ions to different fluences. The *I-V*, and *C-V* characteristics, crystal structure, and defect energy levels of the devices were characterized. First-principles calculations were employed to determine the dielectric function of 4H-SiC. To verify the origin of the defect energy level revealed by DLTS, the energy band structure when $V_c(h)$ (carbon vacancy in the 2 - charge state at the h-site) is generated in the lattice was also calculated using a similar method[2]. The results are shown in Fig. 1. The carrier concentration (N_d) increases with the increase of irradiation fluence, which is caused by the competition between radiation-induced defects and the polarization effect. In addition, the series resistance (R_s) and reverse current (I_R) increase with the increase of irradiation fluence, the forward current decreases with the increase of irradiation fluence. All those shows that the defects generated by irradiation significantly degrade the electrical properties of

Ni/4H-SiC SBD.

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5 - 14 Effect of Temperature on the Oxide Film of Austenitic Steel 15-15Ti in High-temperature CO_2

Qi Le, Liu Chao and Shen Tielong

Supercritical CO_2 is an important candidate cooling medium in advanced nuclear energy systems. Compared with steam Rankine cycle, the supercritical CO_2 Brayton cycle has higher energy conversion rate, compact power system equipment and lower economic investment, and has great application prospects in advanced nuclear energy systems such as high temperature gas-cooled reactors. However, the core exit temperature of nuclear reactors with the CO_2 Brayton cycle is usually 450∼650 ℃, which will lead to serious oxidation corrosion problems of candidate materials and significantly shorten their service life. Austenitic steelis a candidate material for advanced nuclear energy systems such as lead-cooled fast reactors (LFR) and supercritical water reactors (SCWR). It is expected to be used in CO_2 Brayton cycle systems because of its excellent corrosion resistance and radiation resistance and high-temperature strength. Therefore, it is necessary to evaluate and study the corrosion behavior of austenitic steels in high-temperature CO_2 and carefully characterize the physical structure and elemental composition of the oxide film at different temperatures.

Table 1 Chemical composition of the 15-15Ti austenitic steel (wt.%).

Steel	Fe	Cr	Ni	Mn	Mo	Si	C	Ti
15-15Ti	Bal.	15.99	14.78	1.41	2.13	0.39	0.058	0.31

In this study, austenitic steel 15-15Ti was tested in the high-temperature CO_2, and the chemical composition is shown in Table 1. A series of corrosion tests were conducted in a high-temperature oxidation furnace at 550∼650 ℃ for a period of 50∼200 h.

Figure 1(a) shows the XRD results of the oxide films after exposure to CO_2 at 550∼650 ℃ for 50∼200 h. The peaks of matrix (Austenite), Fe_2O_3, Fe_3O_4 and/or spinel ($FeCr_2O_4$) were observed. When the specimens were exposed to high-temperature CO_2 for 50 h, the intensity of the matrix peaks gradually decreased with increasing temperature and disappeared at 650 ℃, indicating that the thickness of the oxide film gradually increased with the increase of temperature. Figure 1(b) shows the results of Raman spectra of the specimens exposed to CO_2 at 550∼650 ℃ for 50∼200 h. Similar Raman peaks were observed for the different specimens. The features observed at ∼221, 241, 290, 404, 496, 607 and 1 310 cm^{-1} were attributed to the Fe_2O_3 structure, while the Raman feature at ∼661 cm^{-1} was attributed to the Fe_3O_4 structure[1]. The results showed that the thickness of oxide film gradually increased with increasing temperature, but the phase structure of the oxide film did not change.

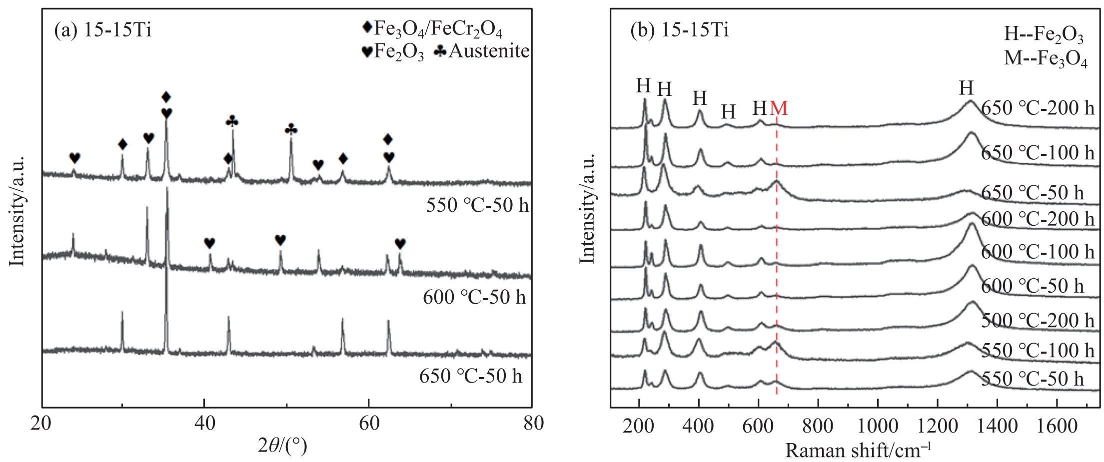

Fig. 1 (color online) (a)XRD patterns and (b) Raman spectra of the oxide films on 15-15Ti steel after exposure to CO_2 at 550∼650 ℃ for 50∼200 h.