5 - 12 Irradiation Hardening Behavior of Long-term Thermal Ageing Martensitic Steel

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From the first generation in the 1950s, the nuclear power system has now developed into the advanced fourth generation[1]. The degradation of material physical and mechanical properties caused by irradiation has always restricted the development of nuclear energy system. In order to address issues such as producing nuclear energy, proliferating nuclear fuel, transmutation nuclear waste and solving the problem of nuclear criticality safety, the accelerator driven subcriticality (ADS) system for advanced nuclear devices was proposed by the international community in the 1990s. At present, the recommended material selection range includes ferritic martensitic heat resistant steel, austenitic heat resistant steel, ODS steel[2,3].

P92 steel was a candidate material for the ADS of F/M Steel in the future[4−6]. We used H_2^+ to irradiate P92 steel, which was treated with thermal aging at different times as 0, 30 000, 47 000, 56 000, 70 000 h, respectively, and nanoindentation test was conducted. The results are as follows.

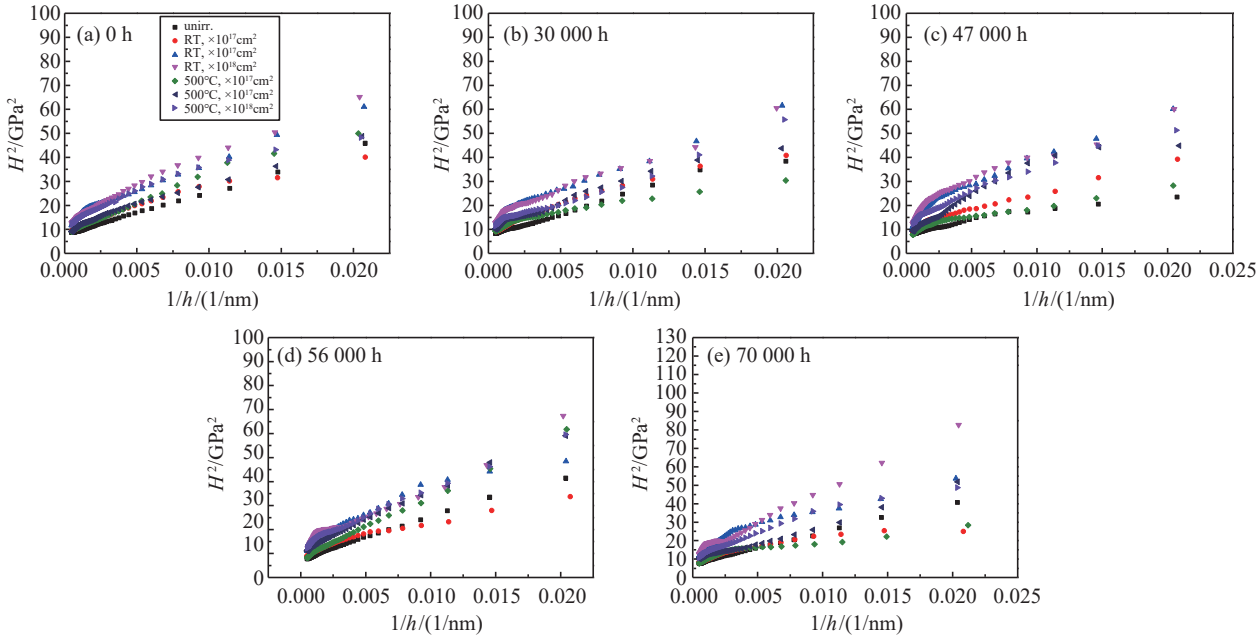

Fig. 1 (color online) The hardness analysis of samples with the same aging time (a)0 h, (b)30 000 h, (c)47 000 h, (d)56 000 h, (e)70 000 h at different doses (unirr., 1×10^{17}/cm^2, 5×10^{17}/cm^2, 1×10^{18}/cm^2, 1×10^{17}/cm^2, 5×10^{17}/cm^2, 1×10^{18}/cm^2) and temperature (RT and 500 ℃).

Figure 1 shows the hardness analysis of samples with the same aging time at different doses. The abscissa is the reciprocal of the depth from the surface ($1/h$), and the ordinate is the square of hardness (Gpa^2). The blank samples without irradiation were also subjected to nano-indentalion testing. The intercepts of each sample were 7.72, 7.52, 7.30 and 7.10, respectively, in the nano-indentation test. The results showed that the hardness of the sample decreased gradually with the extension of aging time. Compared with blank samples without irradiation, the hardness of samples increases significantly due to irradiation, and the higher the irradiation dose, the more severe the hardening of samples. In addition, the irradiation temperature also has an impact on the hardness of samples, with the increase of the irradiation temperature, the degree of hardening of samples increased.

The microstructure of the samples will be further analyzed by transmission electron microscope (TEM) in the future.

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

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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].

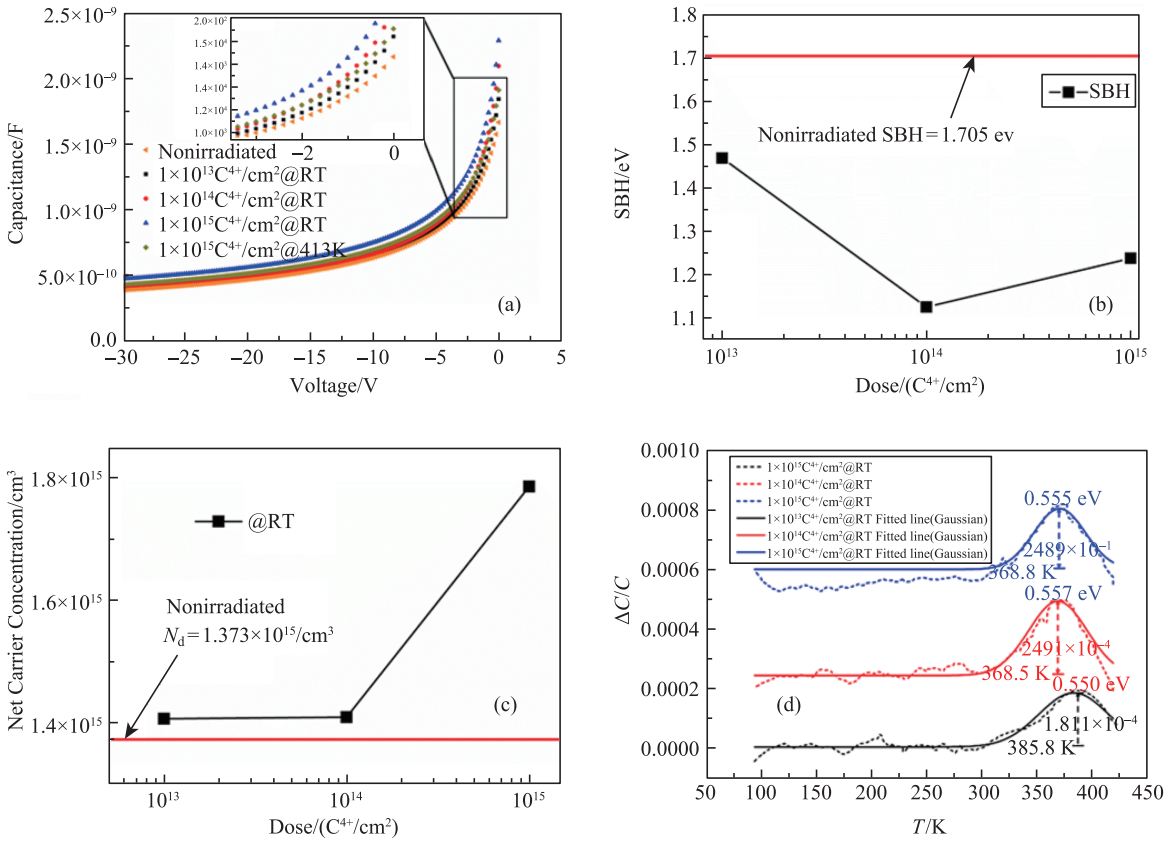

Fig. 1 (color online) (a) *C-V* characteristics at different fluence, (b) SBH at different fluence, (c) Net carrier concentration at different fluence, and (d) Reverse *I-V* characteristic curve.

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