Particle irradiation of 3C

Change of electrical and optical properties

Defects

- Particle irradiation gives defects
  - Vacancies, interstitials, antisites, complexes
- More massive particles, less uniform distribution of defects

Electrical properties

Electrical properties

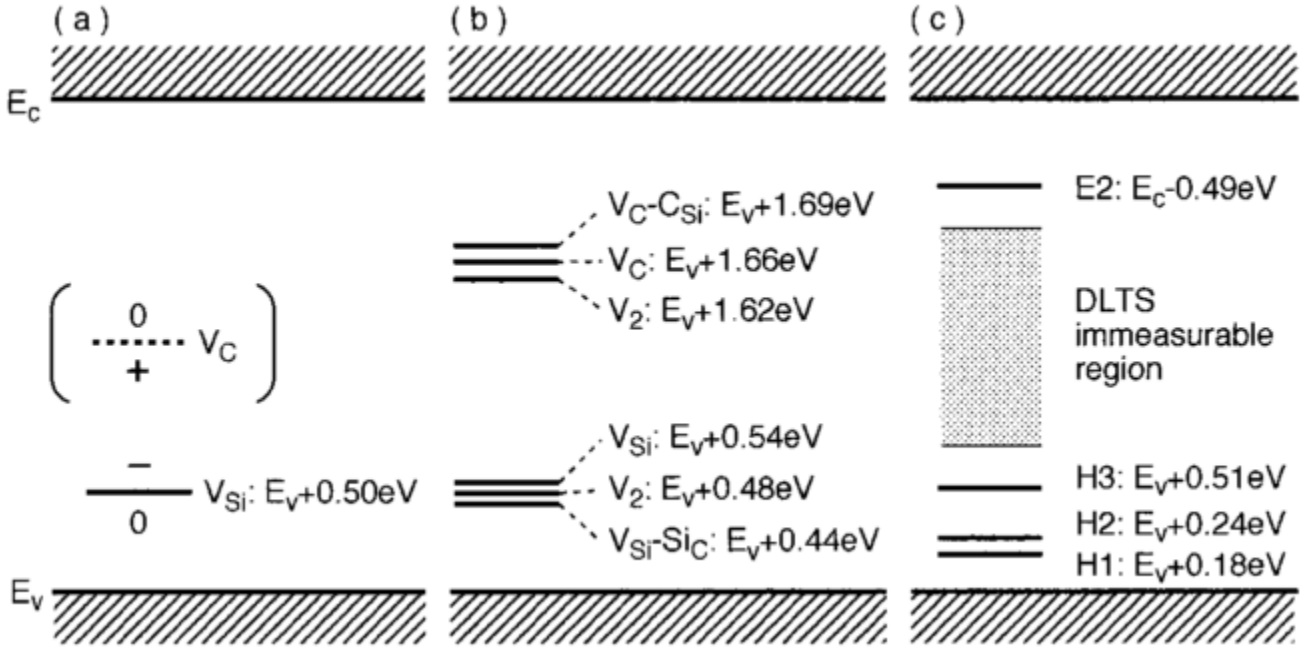


Figure from [1]

Electrical properties

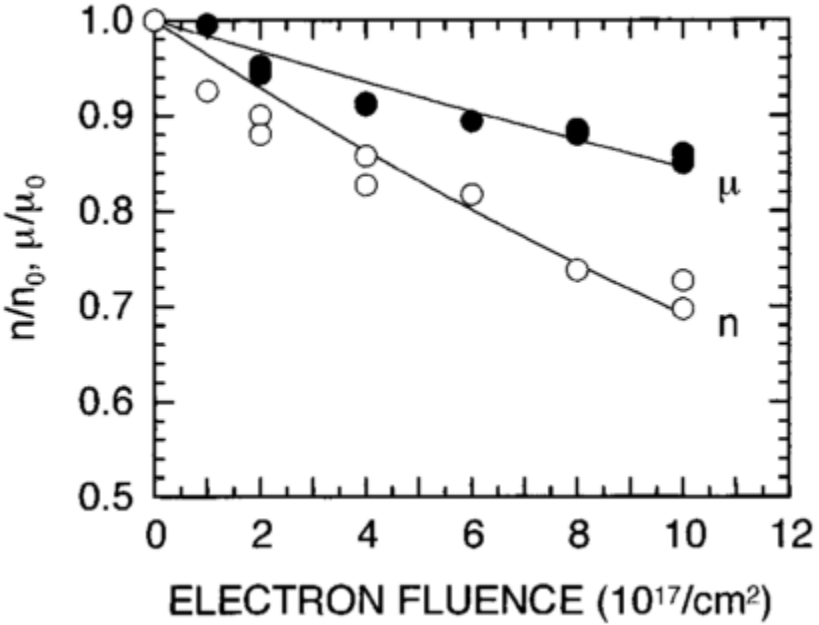
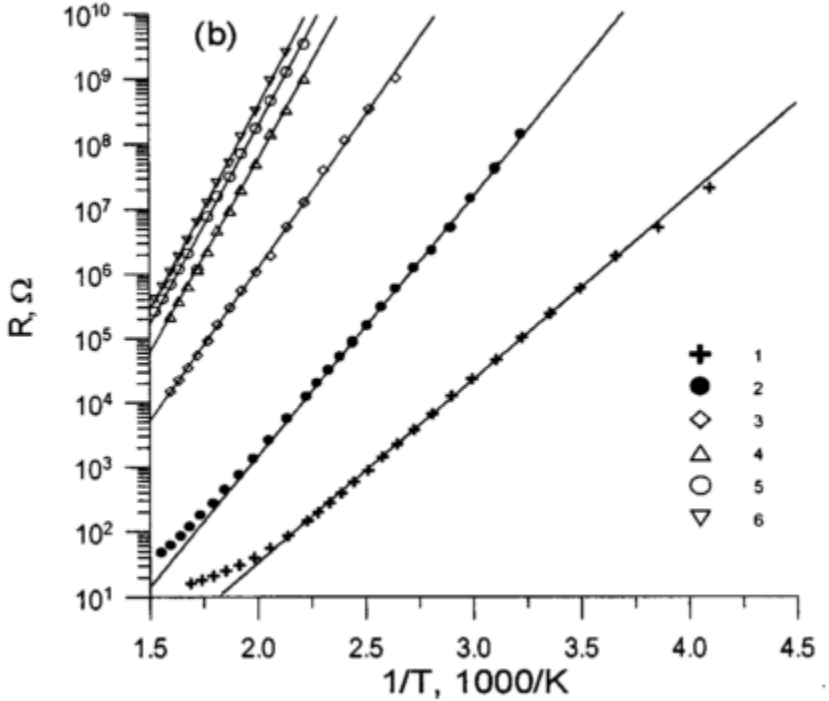


Figure from [1]

Electrical properties



(4H, proton irradiation)

Figure from [2]

Optical properties

Optical properties

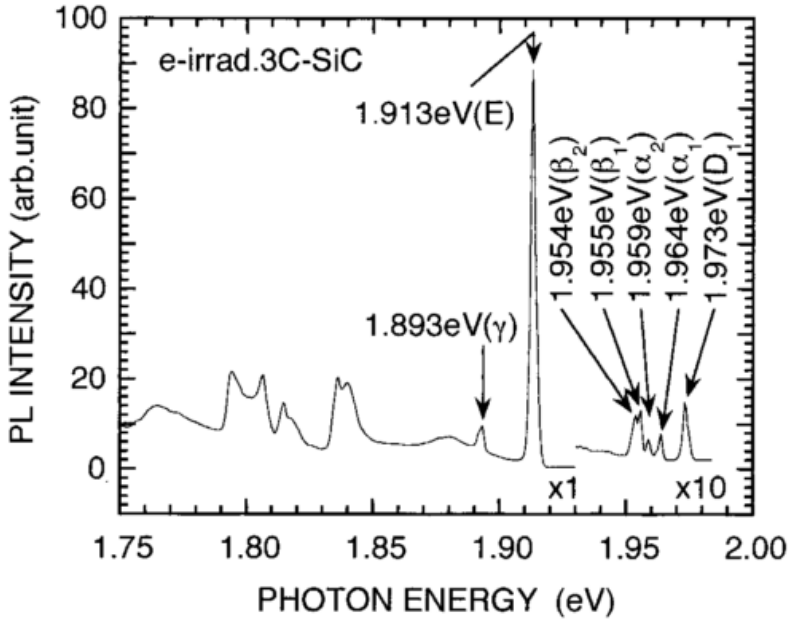
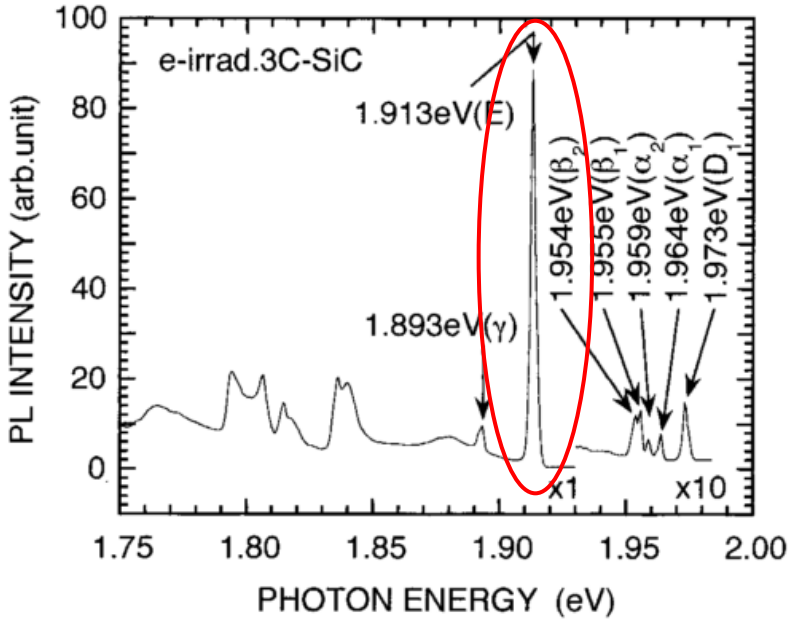


Figure from [1]

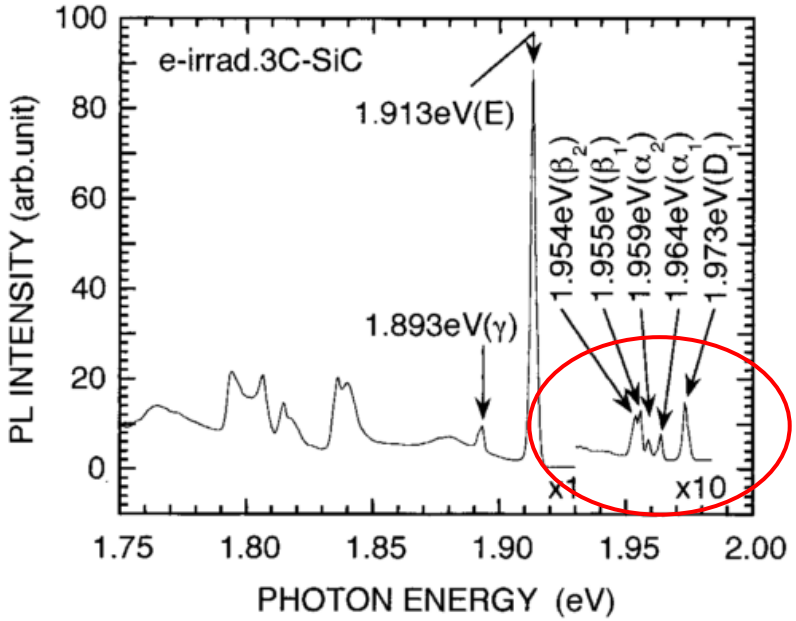
Optical properties



Si-vacancy.

Figure from [1]

Optical properties



D1 defect and phonon replicas

Figure from [1]

Optical properties

The D1-defect in annealed sample

PL at 80 K

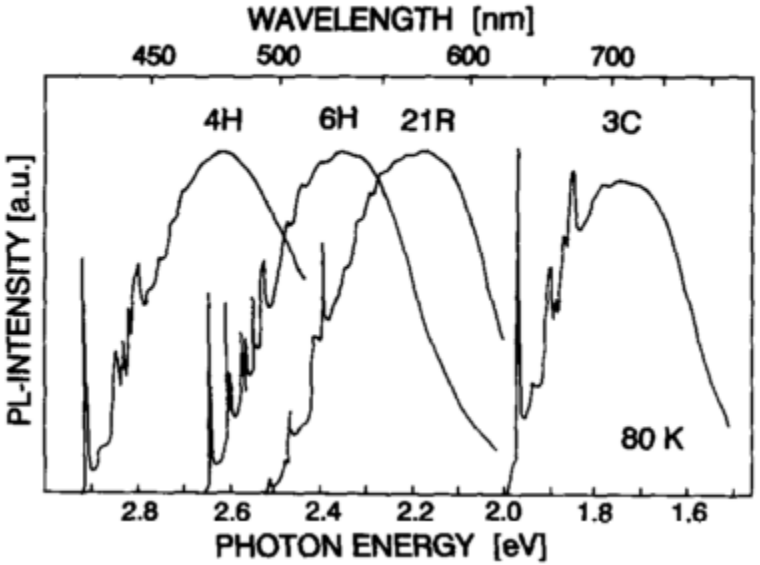
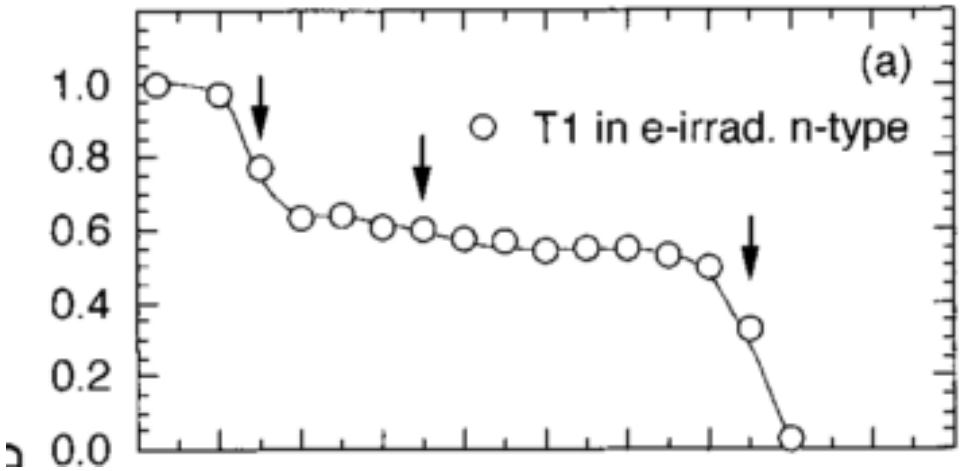


Figure from [3]

Annealing after irradiation

- Some types of defects disappear after annealing at characteristic temperatures
- Si vacancy disappears at 750 C.

Annealing after irradiation



Temperatures 0-1000 C.

Figure from [1]

Annealing after irradiation

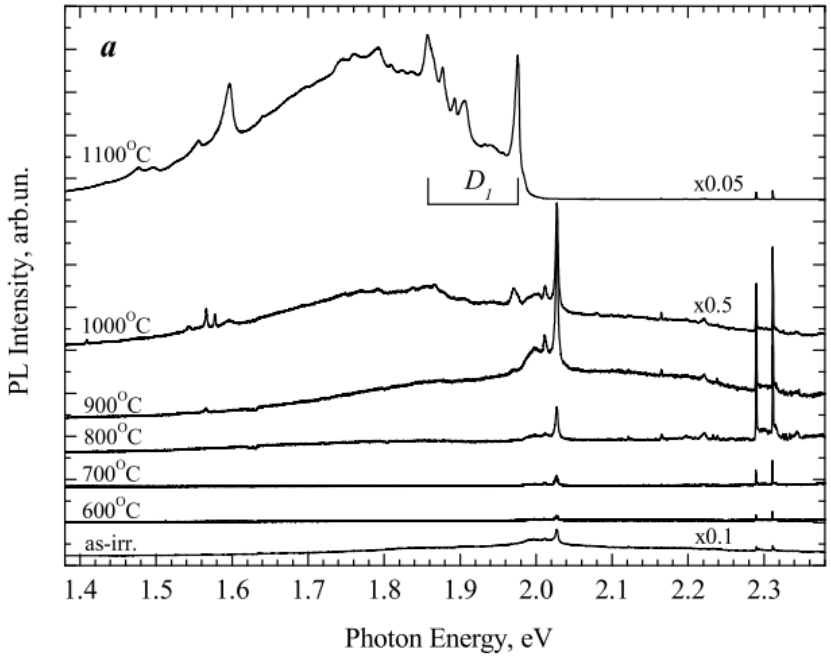


Figure from [6]

Annealing after irradiation

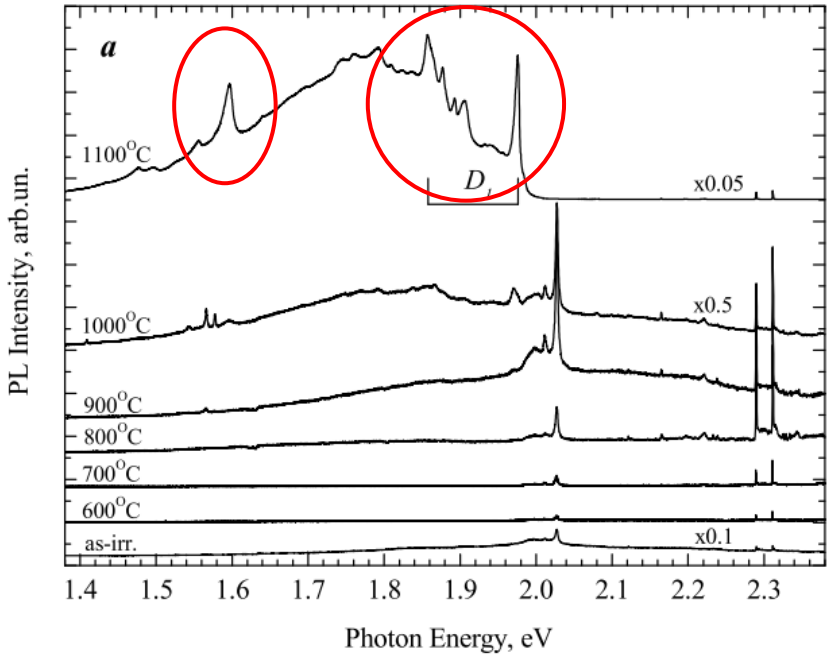


Figure from [6]

Conclusions

- Irradiation can **increase resistivity** in n-doped SiC.
- **Si vacancy** is the strongest defect PL signal before annealing (E=1.91 eV).
- Annealing **removes** several types of **defects.**
- Annealing **amplifies D1** band (E=1.97 eV).
- No studies have shown irradiation of **p-type** 3C.

References

1. H Itoh, A Kawasuso, T Ohshima, M Yoshikawa, I Nashiyama, S Tanigawa, S Misawa, H Okumura, and S Yoshida. Intrinsic defects in cubic silicon carbide. *Phys. Stat. Sol. (a), 162:173, 1997.*
2. Lebedev, Veinger, and Davydov. Doping of n-type 6H SiC with defects created with a proton beam. *Journal of Applied Physics, 88 (2000):6265–6271, 2000.*
3. Schneider J. and Maier K. Point defects in silicon carbide. *Physica B, 185:199–206, 1993.*
4. W. J. Choyke L. Patrick. Photoluminescence of Radiation Defects in Cubic SiC: Localized Modes and Jahn-Teller Effect. *Physical Review B, 4(6):1843–1847, 1971.*
5. E. V. Kalinina. The effect of irradiation on the properties of SiC and devices based on this compound. *Semiconductors, 41(7):745–783, 2007.*
6. Victor Bratus, Roman Melnyk, Oleksandr Kolomys, Bela Shanina, and Victor Strelchuk. Photoluminescence Spectroscopy of Neutron-Irradiated Cubic SiC Crystals. *Materials Science Forum, 740-742:417–420, 2013.*