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Comparative studies of defect behaviour in deuterated and nondeuterated n-type Si

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Outline

- Hydrogen related defects in high-purity, low-doped FZ Si
- Previous results from hydrogenated samples
- Comparision with deuterated samples
- Comparision of samples with different deuterium concentration

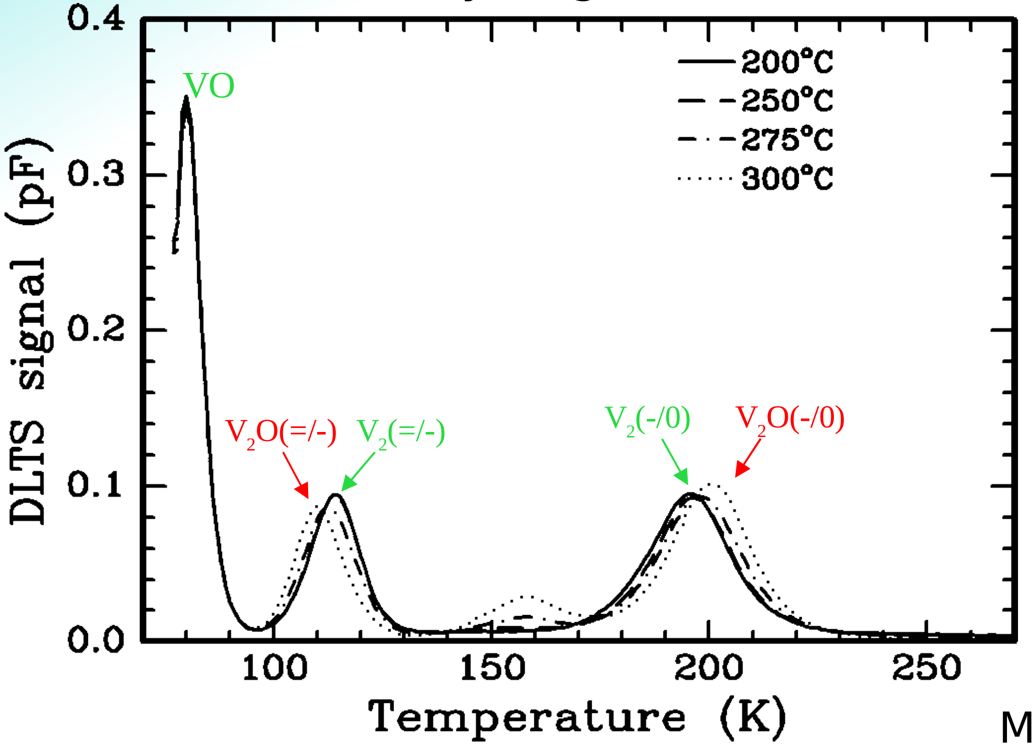
Background

Previous claims of the process $V_2 + O \rightarrow V_2O$

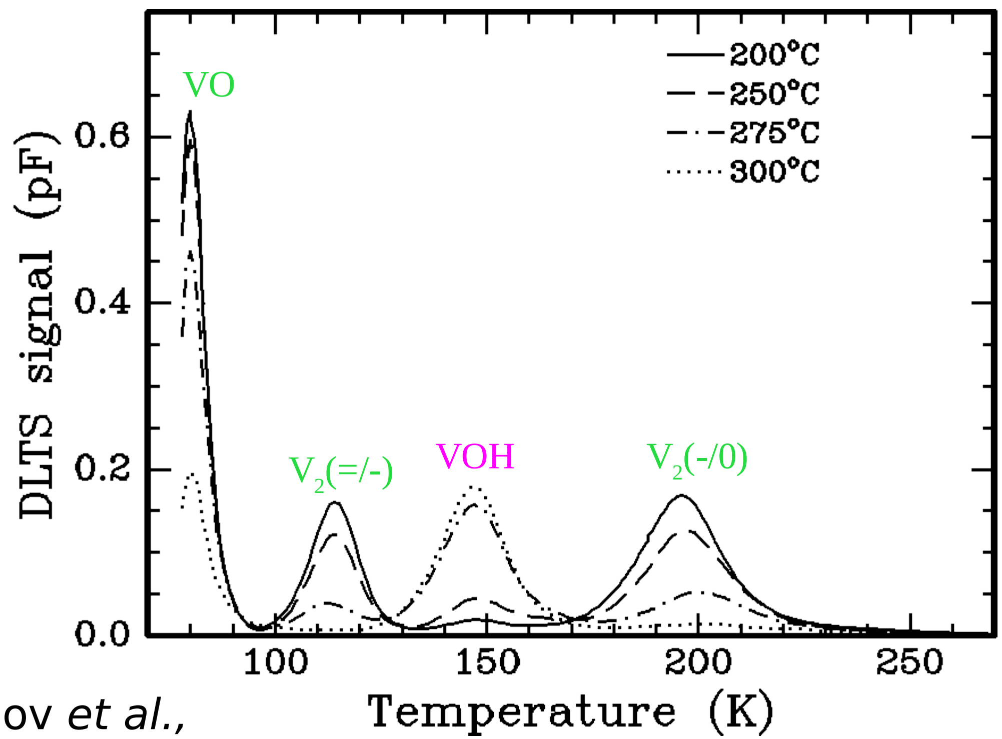
...and hydrogen-assisted annealing of V_2

$V_2 + H_2 \rightarrow V_2H_2$?

Nonhydrogenated



Hydrogenated (2 h in H plasma)



Monakhov *et al.*, PRB **69**, 153202 (2004)

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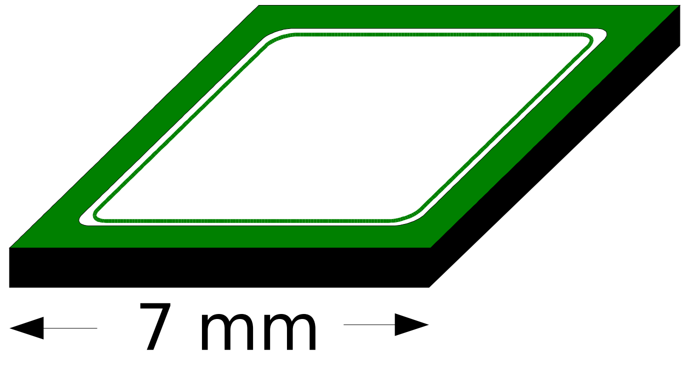
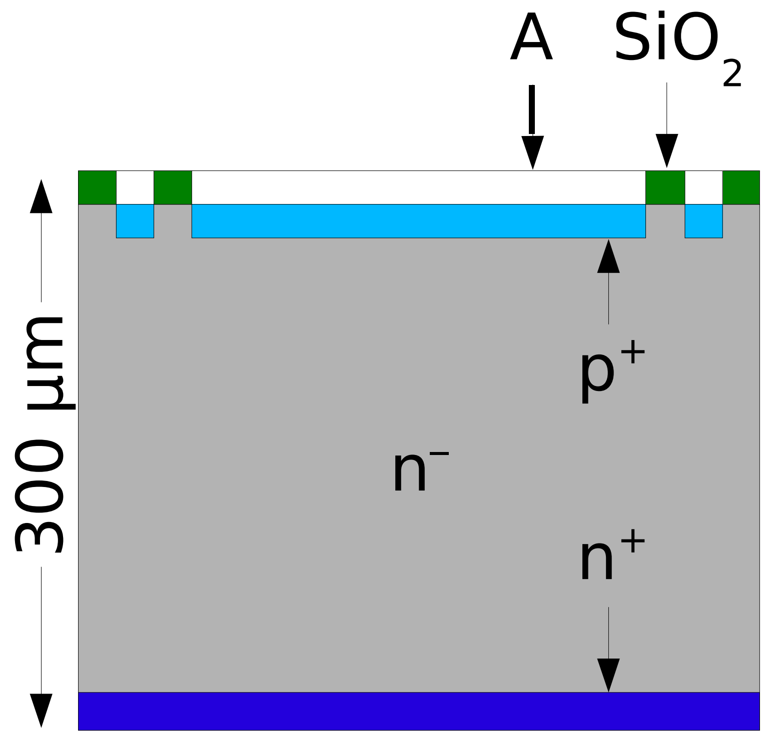
Experimental details

p^+-n^--n^+ Si diodes

- produced from **high-purity FZ wafers** (5×10^{12} P/cm^3)
- **oxidation**: 21 h dry at 1200 °C
- **oxygenation**: 80 h in N_2 at 1150 °C
- ordinary **diode processing**
- 2 and 4 hour **deuteration**:
  n^+ side exposed to D plasma
  (T=150 °C, P=700 mTorr)
- 6-MeV electron **irradiation**: 1×10^{12} cm^{-3}





Results and discussion

DLTS measurements on sample-set 1
(2 h in deuterium plasma)

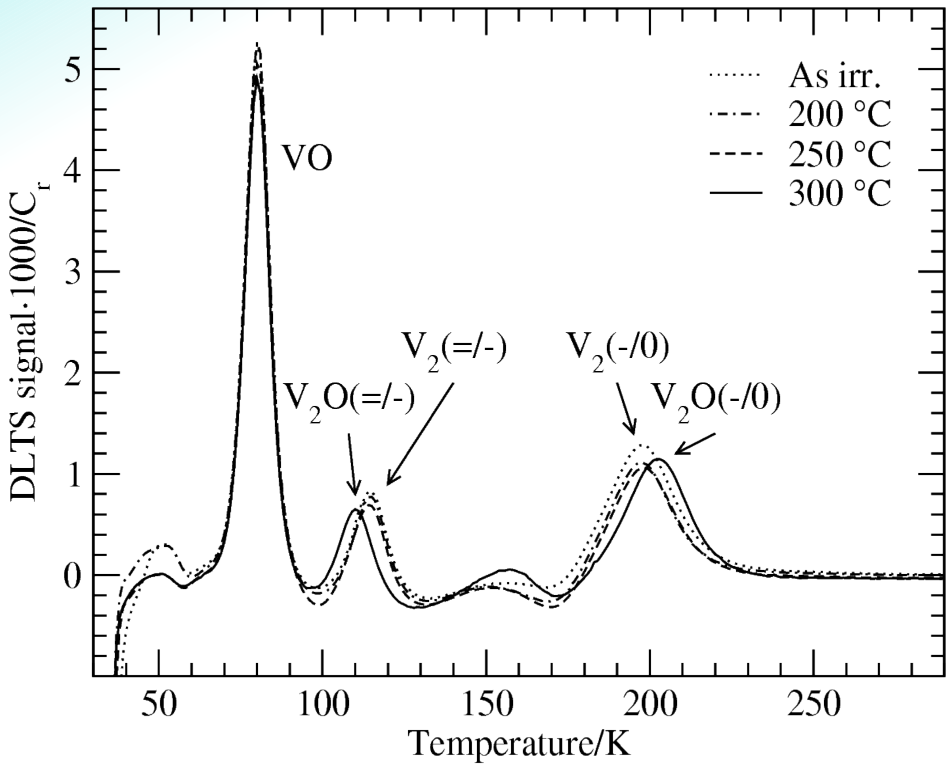
$V_2 + O \rightarrow V_2O$

VO peak stable

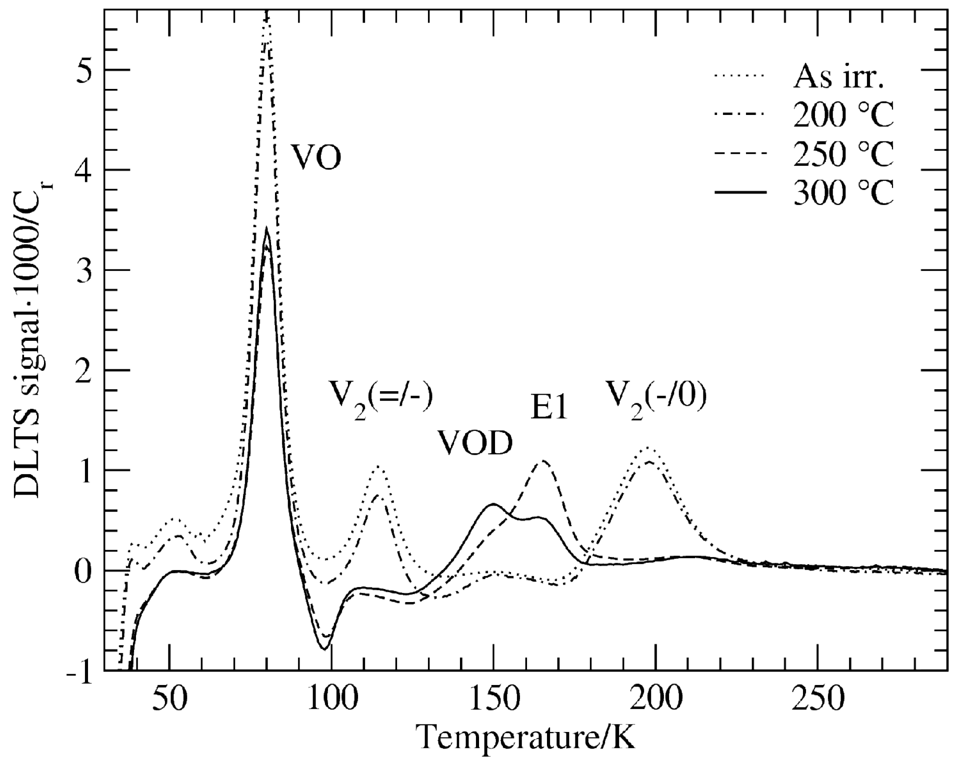
No peak below 77 K identified as V_2D_2 (V_2H_2)

Could E1 be due to $V_2 + D_2 \rightarrow V_2D_2$?

Nondeuterated

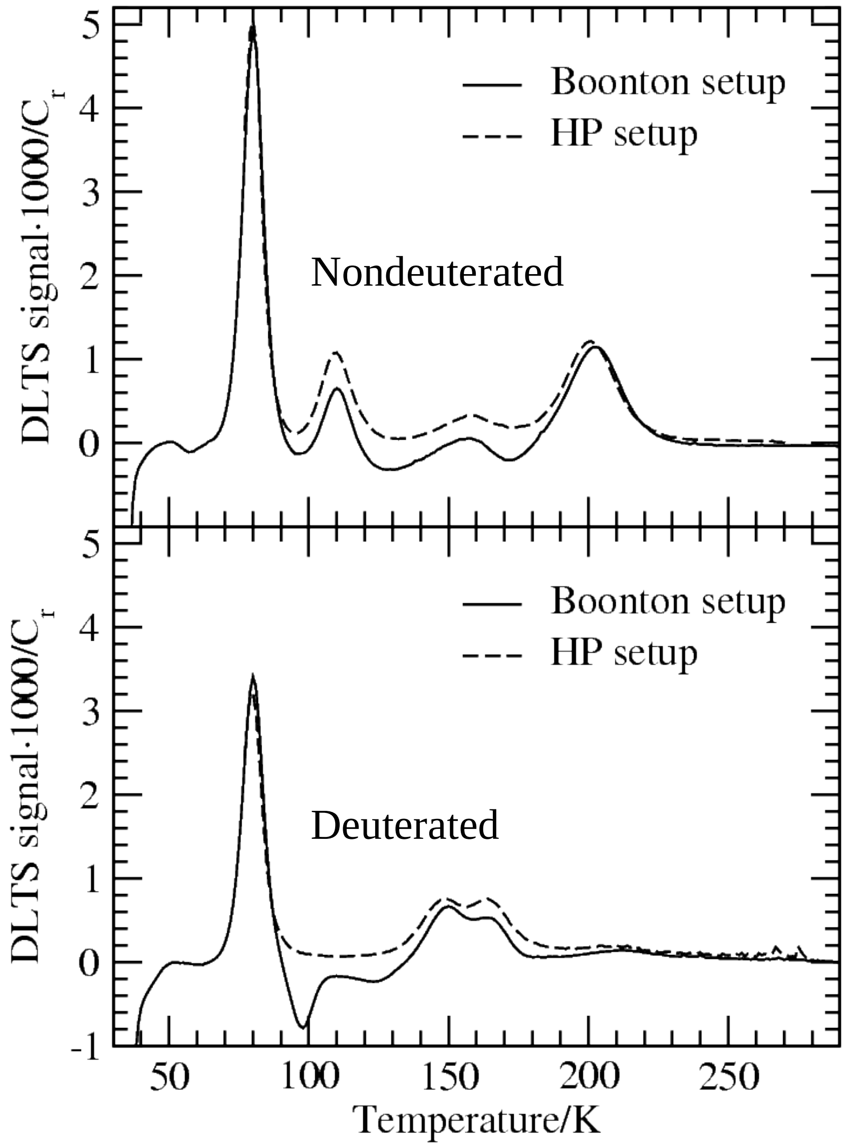


Deuterated



Results and discussion

Boonton 7200 C meter
vs.
HP 4280A C meter



Results and discussion

DLTS measurements on sample-set 2
(4 h in deuterium plasma)

$V_2 + O \rightarrow V_2O$

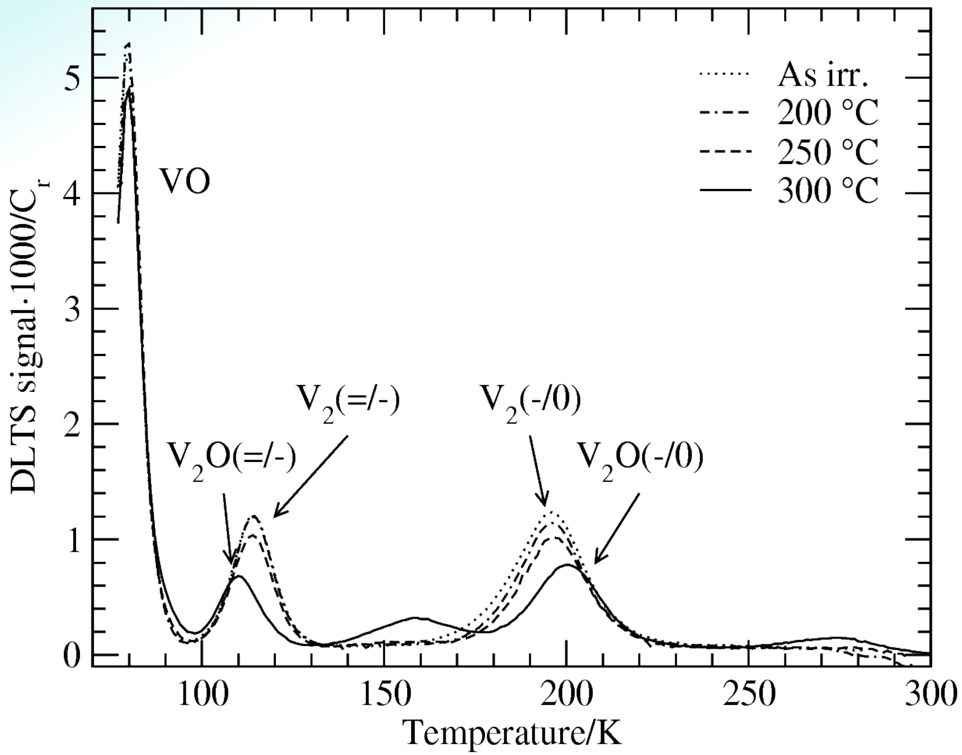
VO peak stable

V_2 anneals while VOD and E1 grow

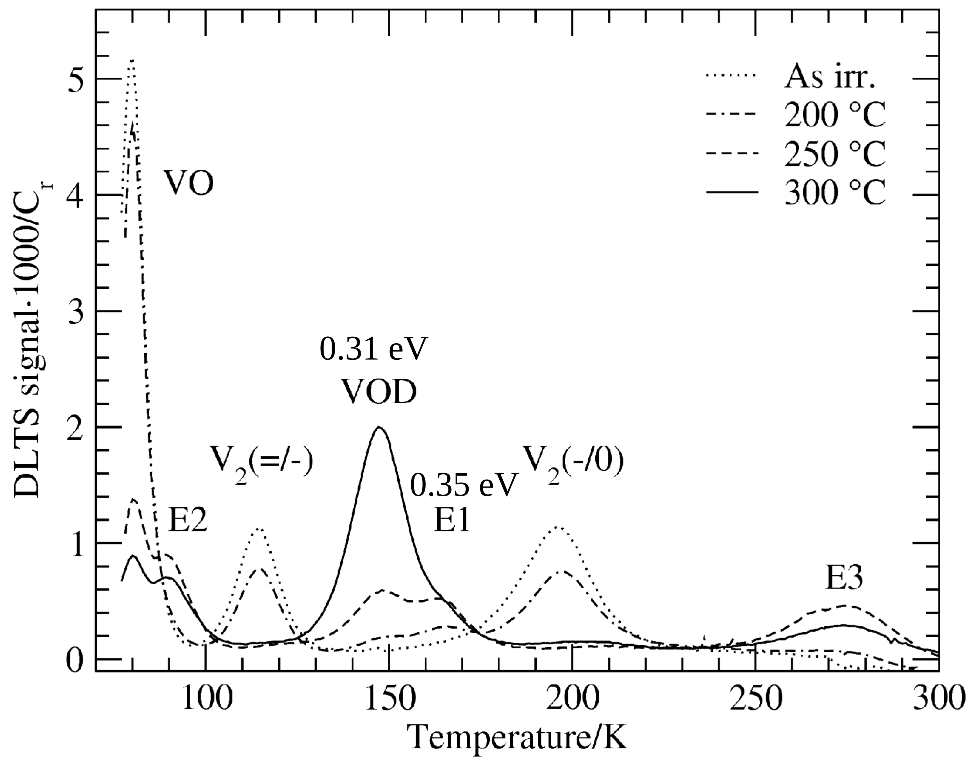
Is $E1 = V_2D_2$?

VO peak anneals

Nondeuterated



Deuterated



Summary

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- $V_2 \rightarrow V_2O$ in nondeuterated samples
- Deuterium-assisted annealing of V_2 and VO in deuterated samples
- No peak that can be associated with V_2D_2 is observed shallower than $E_c - 0.2$ eV
- A peak E1 with energy level $E_c - 0.35$ eV is observed (V_2D_2?)
- Higher deuterium concentration causes more VO annealing, higher maximum amplitude of the VOD peak and two additional peaks E2 and E3

Future activities

- Isothermal annealing series
- More accurate fitting of the DLTS spectra
- Modelling of the defect dynamics
- Analysis of the spectra after annealing at T > 300 ˚C