R08-15 Photoluminescence of Polished and Etched Semi-Insulating CdTe:In

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Highlights

- Surface Treatment – Important Operation Influencing Detector Performance
- Studied Sample – CdTe:In, Prepared By VGF Method
- Investigation of Photoluminescence Dependence on Surface Preparation
- We Found Deep Level Linked to Surface Damaged Layer

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Experimental Setup

Excitation:

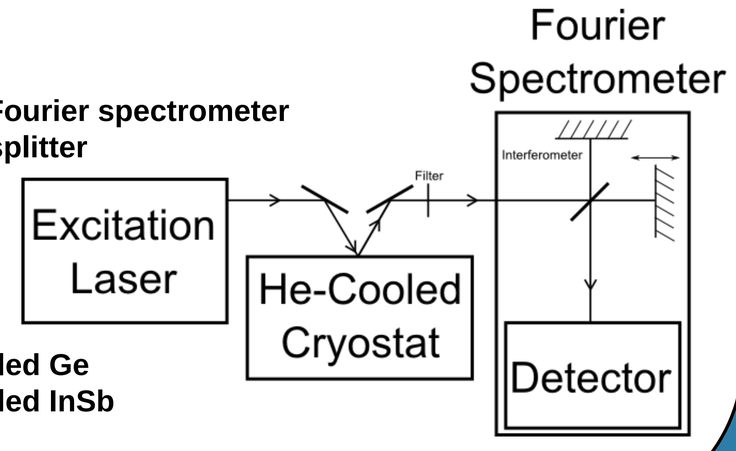
- Laser Radius, continuous, photon energy 1.94 eV
- Tunable Spectra Physics Ti:Sapphire laser, continuous, photon energy 1.16 – 1.72 eV

Cryostat:

- Liquid helium cooled Optistat cryostat

Spectrometer:

- Bruker IFS 66/S Fourier spectrometer with CaF_2 beam splitter

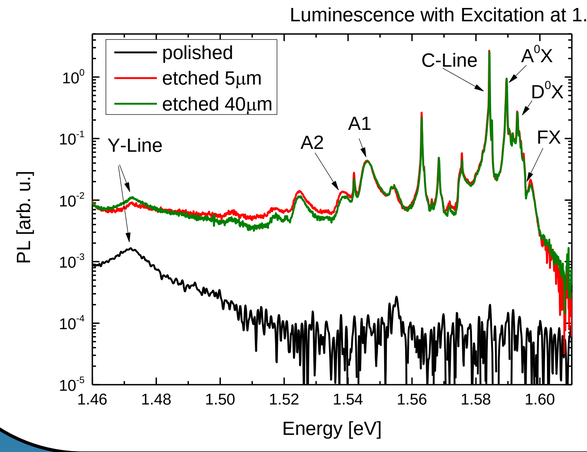


Detector:

- Si – photodiode
- Liquid nitrogen cooled Ge
- Liquid nitrogen cooled InSb

Sample

- CdTe doped with indium, detector grade material
- Polished with 1µm abrasive, surface RMS ≈1.5nm (measured with white-light Zygo interferometer)
- 4 treatments of chemical etching in 1% Br-MeOH solution
- Surface amount etched measured relative to polished surface (5µm, 10 µm, 15 µm, 40µm – from both sides, respectively)
- Polished surface => no near bandgap luminescence, just Y-Line (in literature connected to dislocation defects)
- Etched surface => exciton luminescence visible, Y-Line



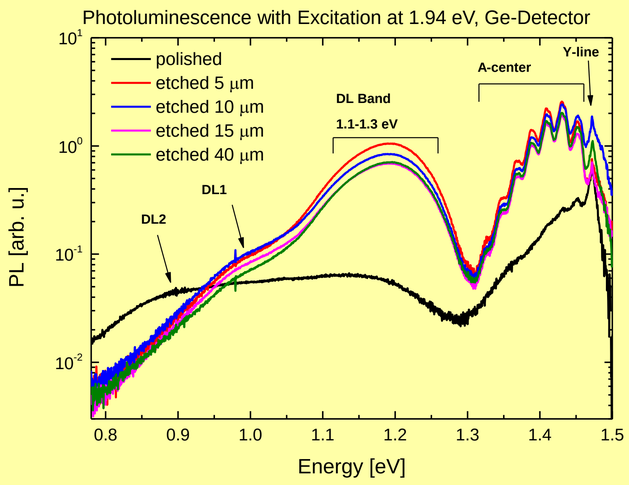
Energy [eV]	Abbreviation	Type
1.596	FX	Free exciton
1.593	D^0X	Exciton bound to donor
1.589	A^0X	Exciton bound to acceptor
1.584	C-Line	Exciton bound to complex defect containing indium
1.546	A1	Shallow acceptor
1.539	A2	Shallow acceptor
1.471	Y-Line	Dislocation defects

Results

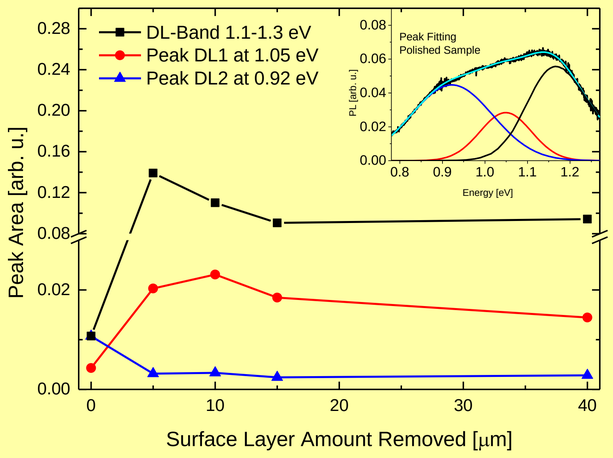
Further Investigation of Deep Levels

Deep levels found:

- 1.30 – 1.46 eV : A-Center
- 1.10 – 1.30 eV : Deep level band (DL-Band)
- 1.05 eV : Deep level 1 (DL1)
- 0.92 eV : Deep level 2 (DL2)
- 0.67 eV : Deep level 3 (DL3)
  - InSb detector used



Peak Area Depending Evolution Depending on Amount of Surface Layer Etched



Fitted Peaks Analysis

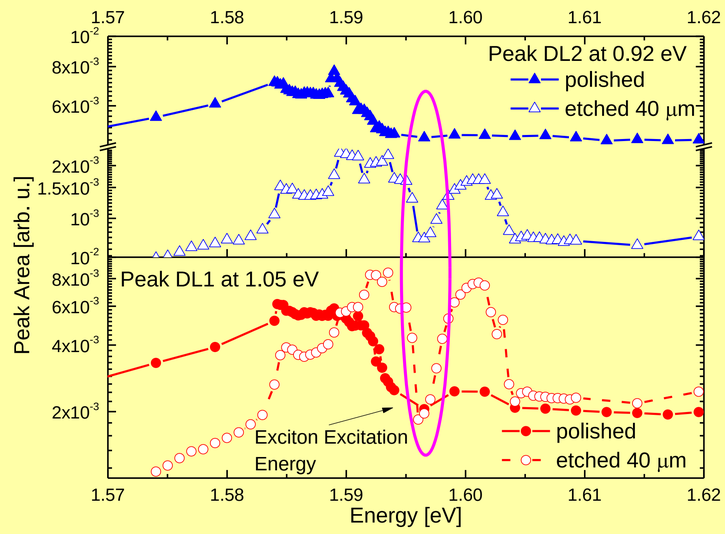
- DL3 remains constant during sample etching
- After slight etching DL2 diminished rapidly
- Photoluminescence of DL and DL-band increases with etching and saturizes
- DL2 is linked to surface damaged layer defects
- Y-Line and DL2 are connected to sample surface, but are independent on each other

Excitation Spectroscopy

- Excitation with tunable Ti:Sapphire laser
- DL1 and DL2 investigation
- Free exciton dip related to crystal lattice quality
- Polished surface:
  - No free exciton dip of DL2
- Etched surface:
  - Photoluminescence increase in exciton excitation region for DL1 and DL2

⇒ DL2 is more susceptible to damaged surface layer
  - DL2 is located closer to sample surface

Excitation Spectroscopy of DL1 and DL2, Tunable Ti:Sapphire Laser, Ge-Detector



Conclusions

- Y-Line (dislocation defect) is independent on sample surface preparation (up to 40 µm)
- A deep level DL2 at 0.92 eV connected to sample surface was found
- Photoluminescence of DL2 diminishes rapidly after etching of 5 µm of the sample
  - Upon polishing photoluminescence of deep level DL2 can be more visible

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