

TG-2 Overview

- Purification of enriched Ge
- Crystal growing at IKZ
- BEGe effort (see talks by Stefan, Dusan)
- SiPM Lar readout (J. Janicsko)

PPM – time schedule defined for purification of ^{enr}Ge



Zeitplan

MPI München - Umarbeitung enriched GeO₂ in Ge poly > 50 Ωcm

Reduktion: Start jeweils gegen 10 Uhr mit 5,6 kg GeO₂, Dauer 44 h

| | |
|----|----------|
| 1 | 09.03.10 |
| 2 | 15.03.10 |
| 3 | 17.03.10 |
| 4 | 22.03.10 |
| 5 | 24.03.10 |
| 6 | 29.03.10 |
| 7 | 06.04.10 |
| 8 | 12.04.10 |
| 9 | 14.04.10 |
| 10 | 19.04.10 |

Zonenreinigung: ca. 8 kg Ge, Dauer 24 h

Erster Durchgang jeweils mit 2 Reduktionschargen,
weitere Durchgänge nach Bedarf

Abschluss der Arbeiten spätestens 30.04.10

Have offer from PPM: final issue
regarding insurance still being
clarified

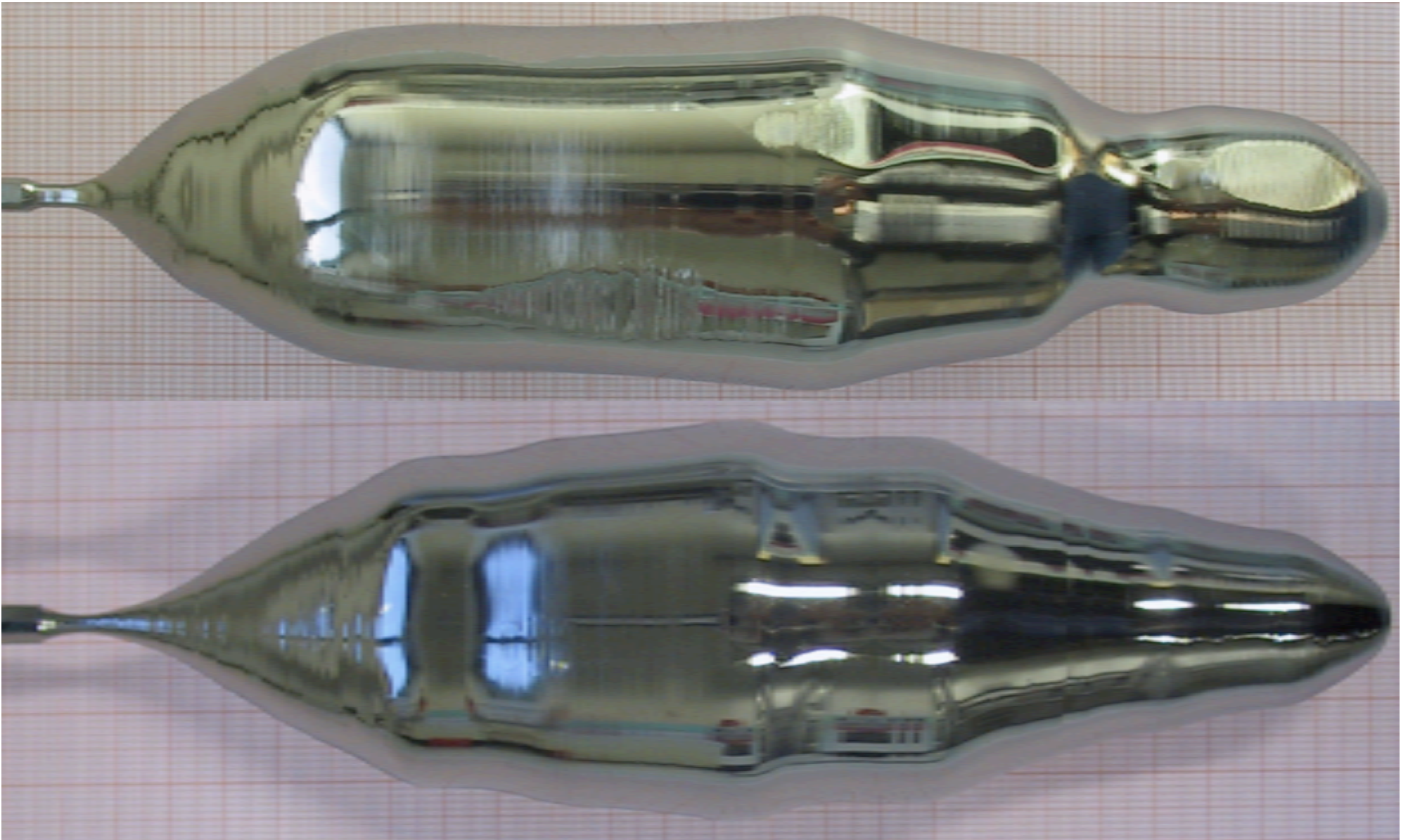
Have offer from Weltkulturerbe
Rammelsberg for storage of
material underground.

Josef Janicsko will handle all
transports/bookkeeping. On-site
at PPM.



IKZ

- since last meeting, two new xtals grown in mini-CZ puller (converted float-zone puller). Total now 17 xtals pulled.



Electrical characterization of the Ge crystal Ge-HP-17 (miniCZ-3)

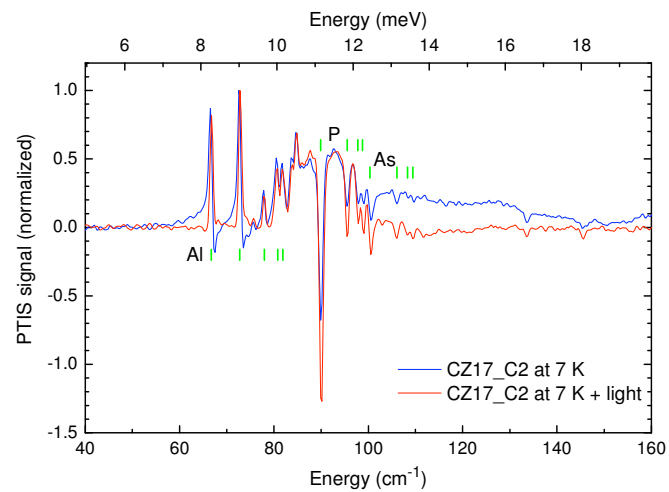
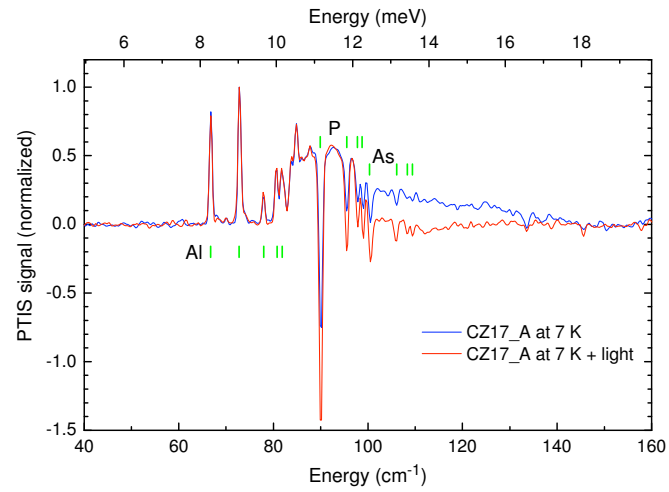
| CZ17 | Starting material | Susceptor | Crucible | Atmosphere |
|--------------------|---|------------------------|----------------------------|-----------------------------------|
| Furnace FZ-1605 | PPM (⁷⁶ Ge-depleted Ge) 1.312 kg | TCM (Ta alloyed Mo) | suprasil 2nd experiment | Ar 6.0 + 4% H ₂ 6.0 |

Conductivity and Hall effect results:

| | Resistivity (Ωcm) | | carrier concentration (cm⁻³) | | Mobility (cm²/Vs) | |
|--|------------------------------|-------------|--|-----------------------------|---|--------------|
| | RT | 77 K | RT | 77 K | RT | 77 K |
| <i>Temperature</i> | | | | | | |
| CZ17_B | 56 | 77 | -9.5×10 ¹³ | +2.0×10¹² | 1170 | 41100 |
| CZ17_D2 | 52 | 754 | -7.8×10 ¹³ | +1.9×10¹¹ | 1540 | 43400 |
| CZ17_F1-2-3 <i>inhomogeneous: 77-K measurements impossible!!</i> | 52-56 | -- | -7.6-8.3 ×10 ¹³ | -- | 1430- 1570 | -- |

An additional set of samples will be prepared from the crystal between the D and E positions. Results are expected in January.

CZ17 - PTIS



Impurities

Aluminum dominates over the sum of phosphorus and arsenic. This is consistent with the p-type conductivity observed in the neighboring samples B and D2. The arsenic concentration is only 10...15% of that of phosphorus. Whether we have really a reduction of the impurities in the crystal going from A to C, as indicated by the Hall measurements, cannot be answered firmly. A change of the compensation ratio is also possible.

Results from Photoluminescence (PL) measurements

Report on Photoluminescence measurements of the following samples, sent by Dr. Abrosimov from IKZ (arrived on 21.12.09):

| Sample name | Description |
|-------------|---|
| GeCz#17B | Sample near the seed of the crystal Cz#17 |
| GeCz#17D | Sample of middle of the crystal Cz#17 |
| GeCz#17F | Sample near the tail of the crystal Cz#17 |

Before performing measurements all samples have been polished and etched 1 min in CP6 solution.

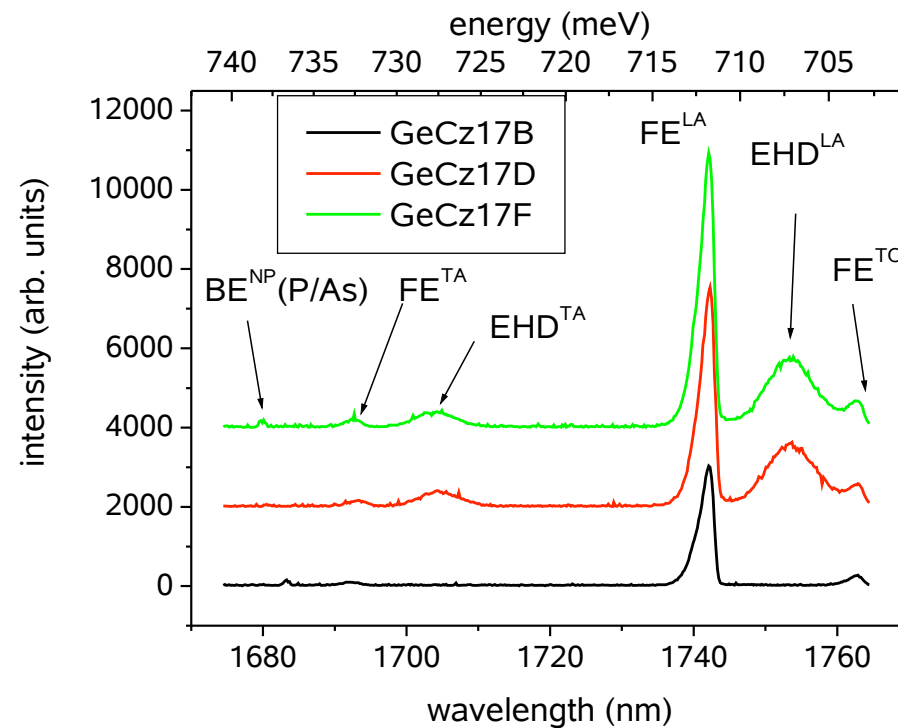


Figure 1: PL spectra of samples from GeCz#17 at $T=4.2$ K with excitation by Argon laser with $P=100$ mW and a spectral resolution of 0.9 nm

- in Figure 1 the spectra of the different samples look quite similar but in the seed end sample lower luminescence intensity
- in the tail end sample impurity correlated luminescence increased
- hints for donors e.g. arsenic or phosphorus; concentration increases from seed to the tail of the crystal
- in Figure 2 spectra with higher resolution of the range around 1680 nm, resolution couldn't be further increased because intensity was too low
- peak not separable in arsenic and phosphorus bound exciton but peak position coincides with phosphorus
- **phosphorus** is main impurity, concentration increases from seed to tail end

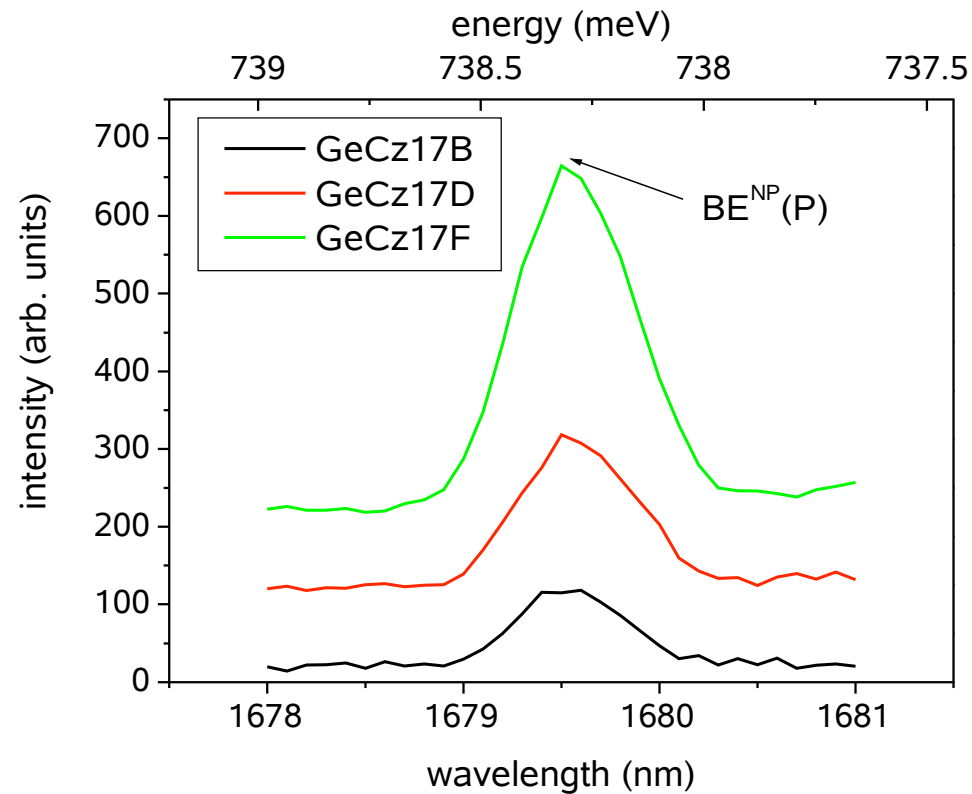


Figure 2: High resolution PL spectrum of the Ge#17 samples at T=4.2 K with excitation by Argon laser with P=500 mW and a spectral resolution of 0.6 nm

Al in Ge:

- in the spectra of an Al doped Ge sample ($6.3 \times 10^{13} \text{ cm}^{-3}$) the LA replica of the bound exciton of aluminum is detectable (but very low signal)
- in the Cz17 samples there isn't any signal in this region
- it seems still that aluminum concentration in the Cz17 samples is below the detection limit with PL
- one could estimate that detection limit for Al in Ge with PL is around 10^{13} cm^{-3}

Legend:

| | |
|-----|--------------------------------|
| BE | bound exciton |
| FE | free exciton |
| EHD | electron hole droplet |
| NP | no phonon |
| TA | transversal acoustic (phonon) |
| LA | longitudinal acoustic (phonon) |
| TO | transversal optical (phonon) |

For better distinction in all figures the second/third spectra got an (artificial) offset.

- Next steps at IKZ:
 - New crystal from rebuilt CZ puller (electropolished) expected this week
 - New crystal from new modified float-zone puller (only used for ultra-high purity, no doping) also expected this week
 - Results within 1 week ??

- Beyond the diodes:
 - Electronics
 - Cabling
 - Lock requirements
 - DAQ requirements
 - MC simulations
- We need to be active on developing these items for Phase II as we start up Phase I