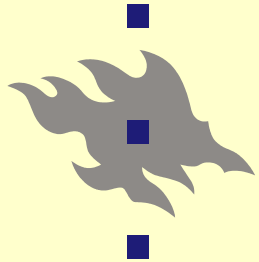
Characterisation of TlBr Crystals for Detector Applications



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Detector properties

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- Crystal quality
- Purity (composition)
- Previous study* => Chemical aspects
- Crystal growth
- Purification

- * V. Kozlov, M. Leskelä, T. Prohaska, G. Schultheis, G. Stingeder and H. Sipilä, Nucl. Instr. and Meth. A (2004) (in press)

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This study => Crystal quality

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- Crystal growth
- Annealing (+hydrothermal)
- Methods:
- X-ray rocking curve
- IV & photo-current
- X-ray Cu-radiation
- Polarisation microscope

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Sample production from the ingot and wafer mapping

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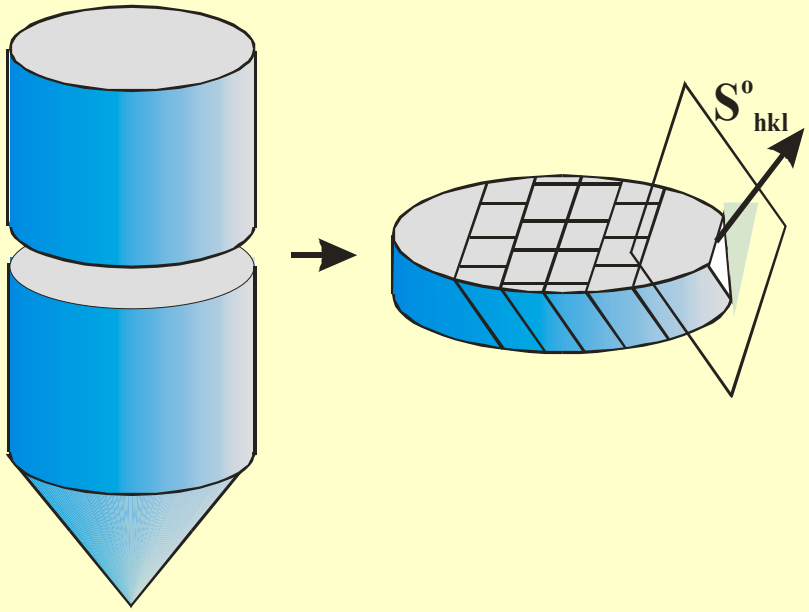

- Two large crystals of diameter 21 mm were grown using Bridgman method

•<= Reference surface: plane (100) or (111)

- Wafers and, then, slices were cut as is presented in Figure

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Rocking curve mapping

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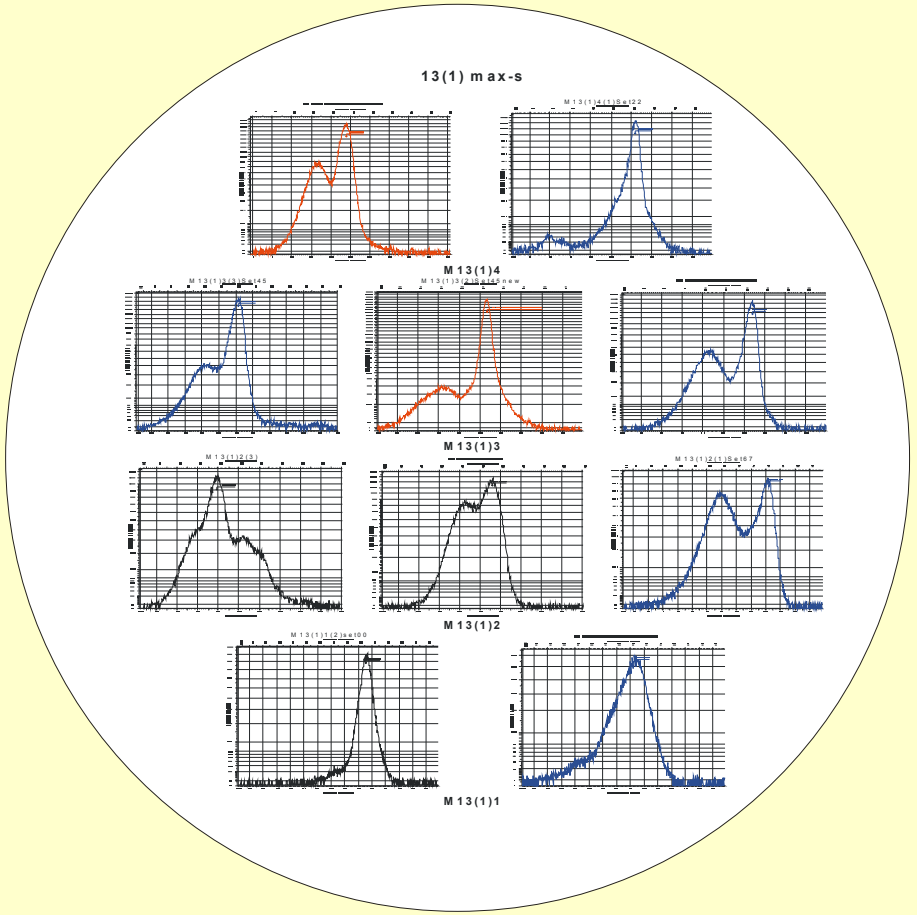
All slices were cut || to reference surface

Reference slices =>



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Annealing: FWHM change

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Ar atmosphere

An03	**Src**	**200°C**
SL02(111)	0.6	0.6
SL05(100)	2.8	1.4
SL06(211)	ND	0.7

Pure water

An04	Src	150°C
13(1)1(1)	2.5	1.2
13(1)2(1)	1.3	0.5
13(2)1(1)	1.8	1.4
13(2)2(1)	1.2	0.8

Abr.:

ND - not detected
13(1)… - (111) planes
13(2)… - (100) planes

An05	Src	225°C
13(1)3(1)	0.7	0.2
13(1)4(1)	0.65	0.2
13(2)2(2)	2.7	0.35
13(2)3(1)	2.5	0.35

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Effects of hydrothermal annealing during 5 days

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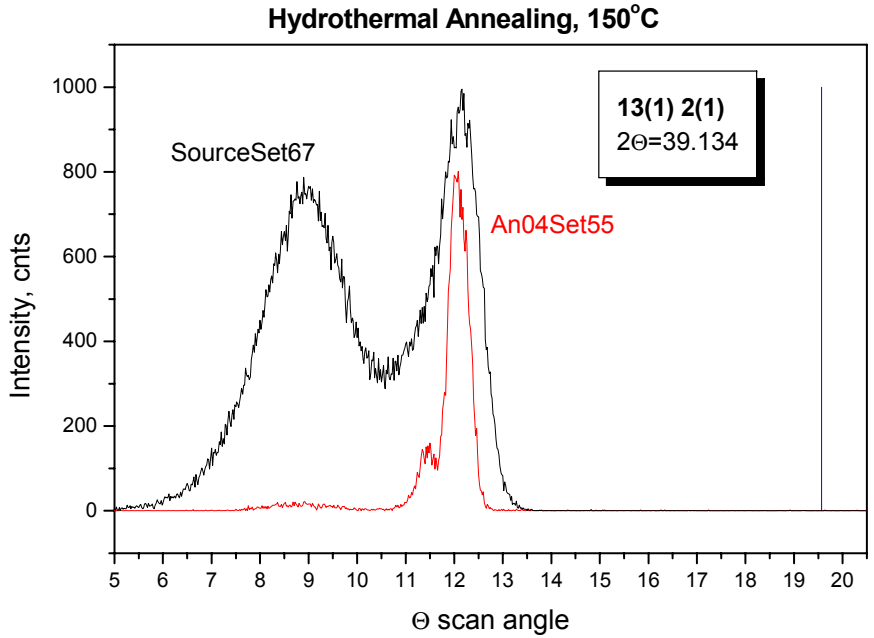

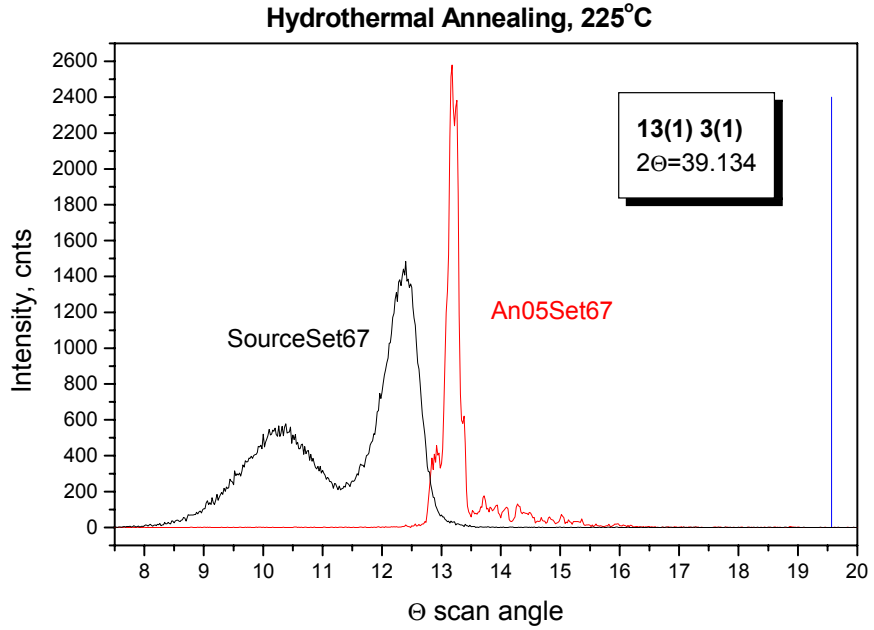

150° C

225° C

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Effect of TlBr crystal annealing

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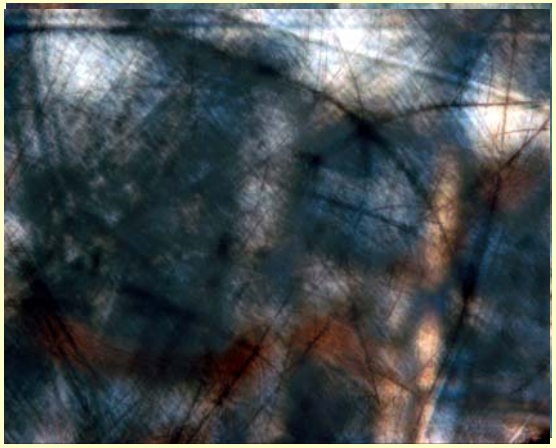

- Source slice10 and annealed slice12
- Sample rotation in Nicole crossed

rotation ~-5°

Source slice10 at a start position

rotation ~+15°

-40°

Slice12 annealed at 225° C at a start position

rotation -42°

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IV-measurements

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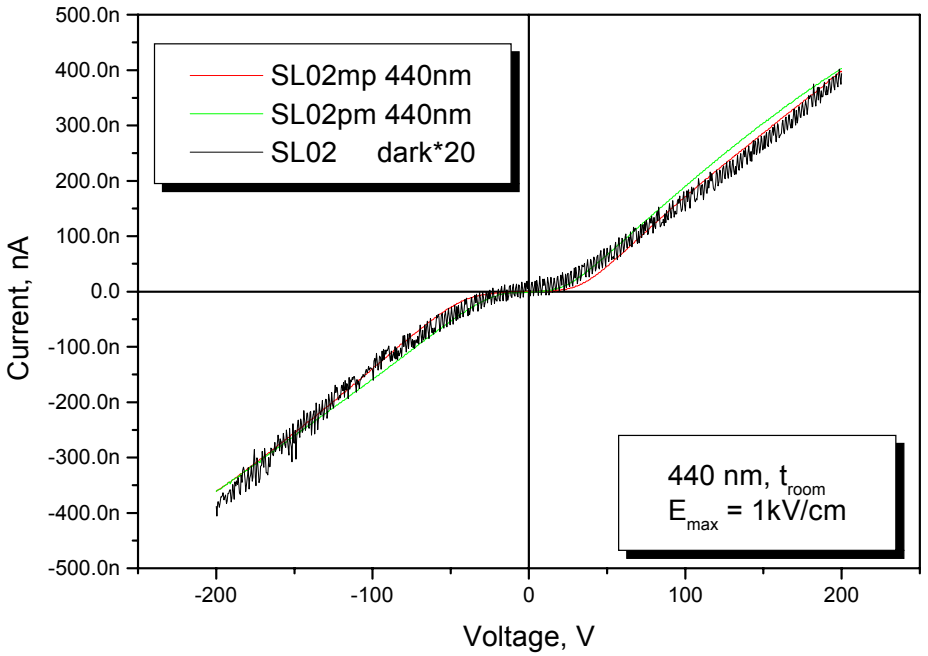

Irradiation: 440nm

<= Dark box

+ “Dark” * 20

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IV: Annealing

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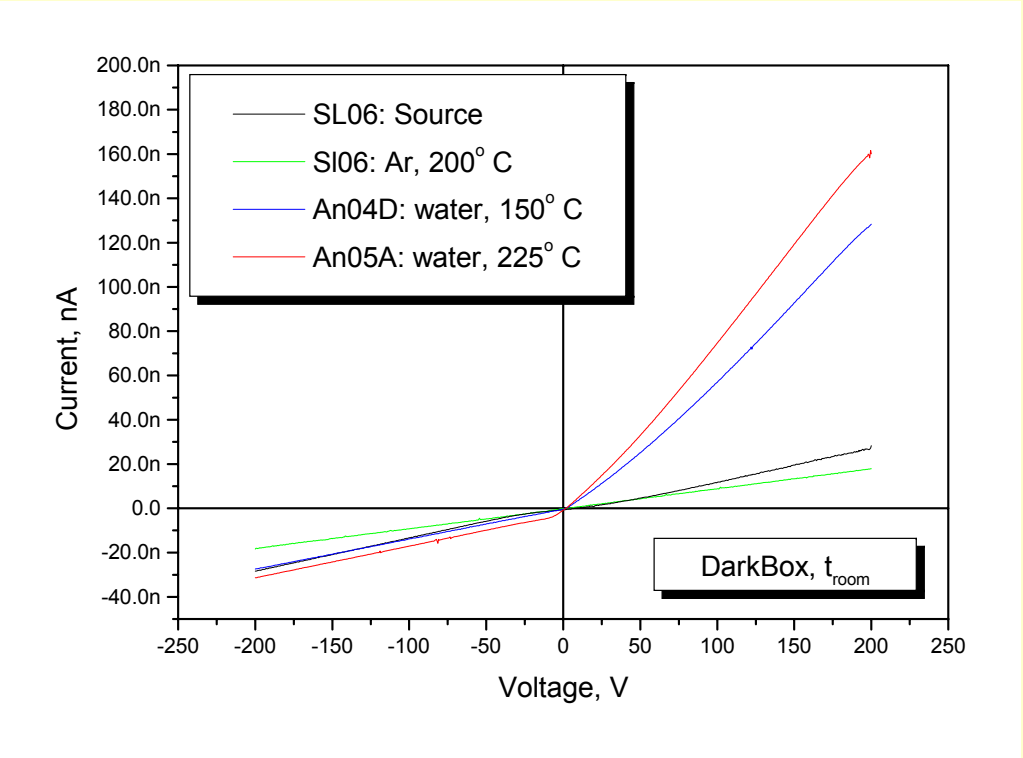

- Annealing: Dry Ar, 200° C
- Annealing: water, 150° C (unstable characteristic)
- Annealing: water, 225° C (unstable characteristic)

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Photo-Current Spectra

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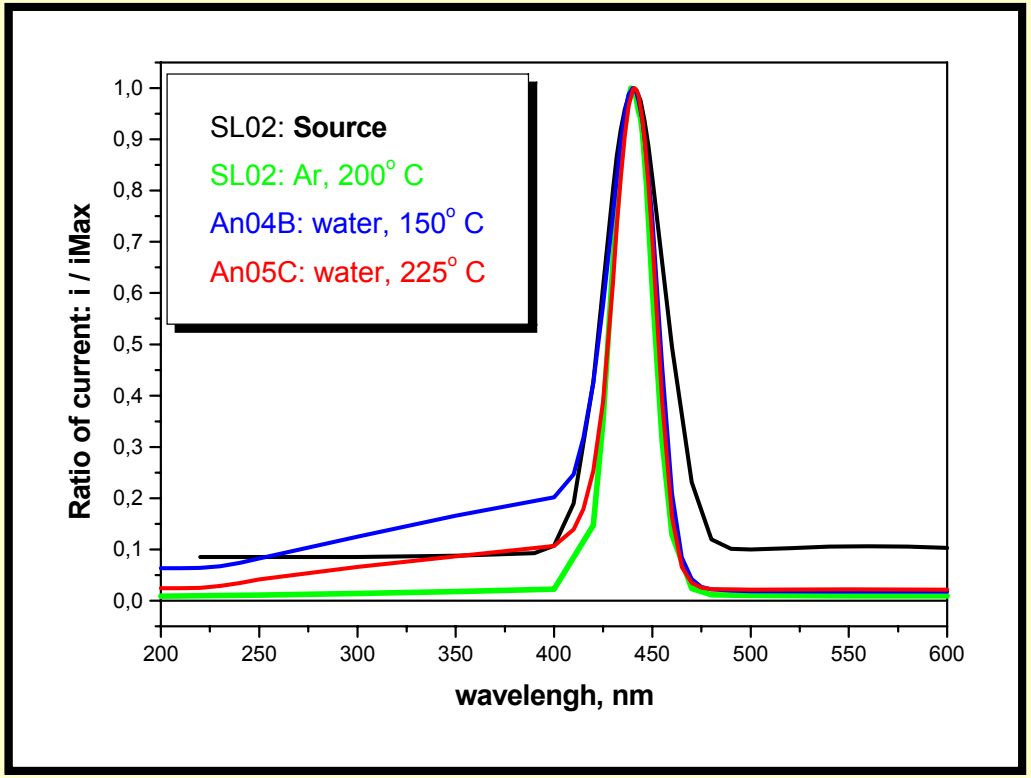

- Non annealed source
- Annealing: Ar, 200° C
- Annealing: water, 150° C
- Annealing: water, 225° C
- Normalisation by Max

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X-ray response

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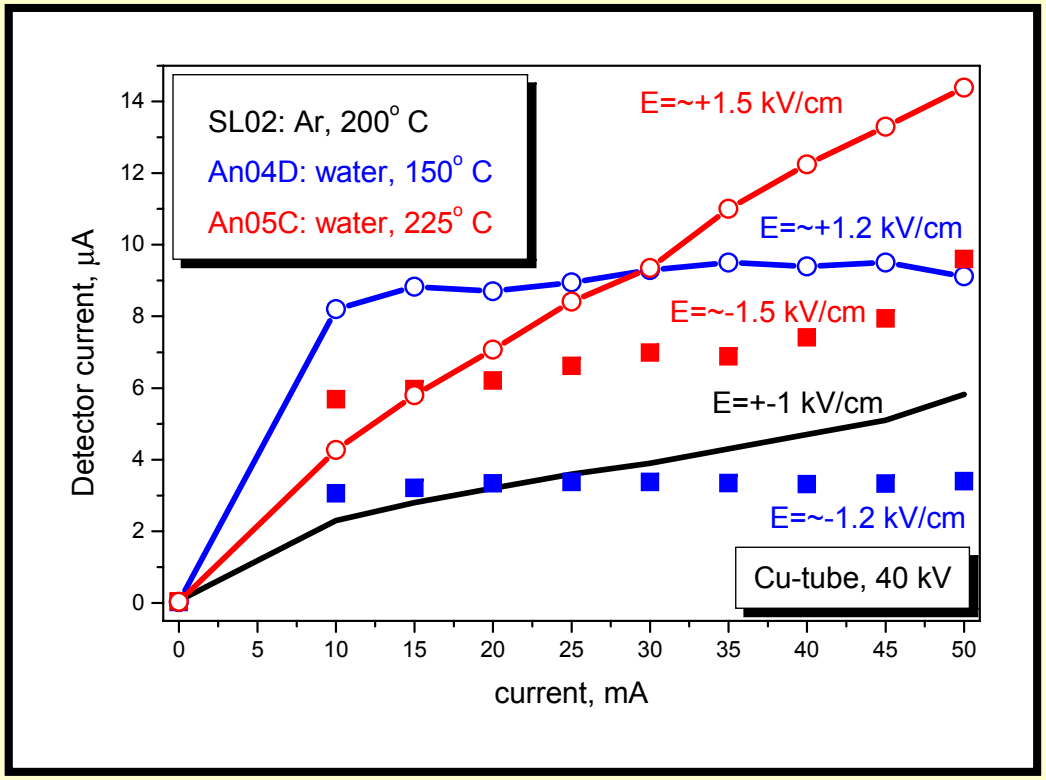

Annealing: Ar, 200° C

Annealing: water, 150° C

Annealing: water, 225° C

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Conclusions

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- TlBr grown from melt is stressed and the block boundaries formed have complicated character
- Annealing improves the crystal quality and as result electrical, optical and detection properties
- Annealing in pure water asymmetrically modifies these properties that is probably caused by the concentration gradient of impurities
- Several samples annealed in pure water reveal characteristics of a semiconductor doped

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Acknowledgements

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- Finnish Technology Agency **TEKES**