

**Christian Doppler Laboratory:**

**Applications of Sulfosalts in Energy Conversion**



# Sulfosalts:

Family of more than 200 naturally occurring, inorganic chalcogenides with complex chemistry and structure.

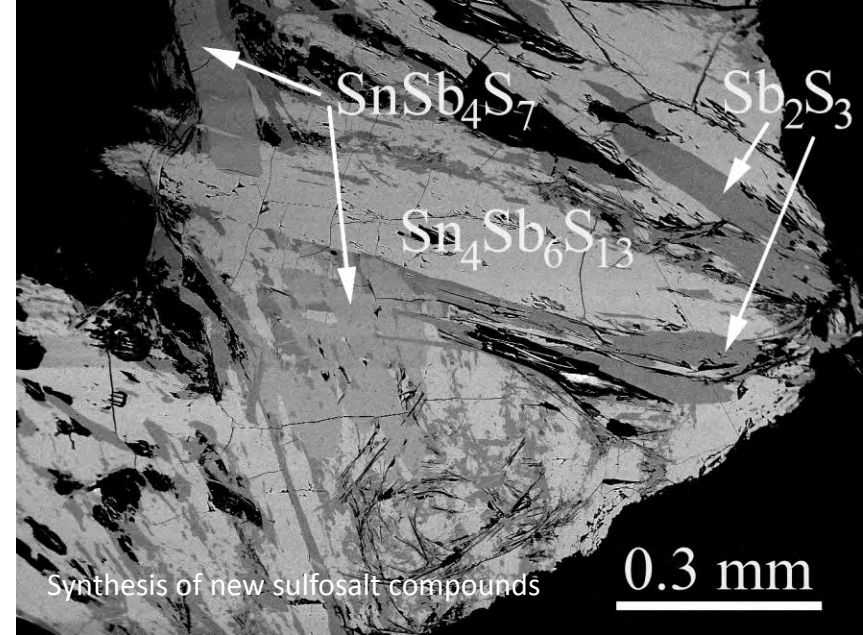
All semiconducting!

Applications in

- thin film photovoltaics
- thermoelectrics
- phase change memory

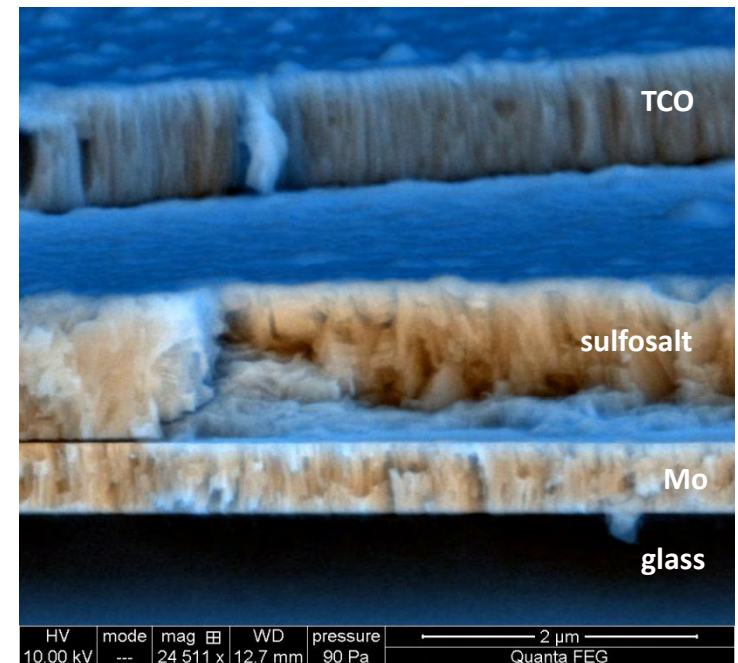


Bournonite Mineral ( $\text{PbCuSb}_3\text{S}_7$ )



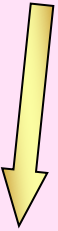
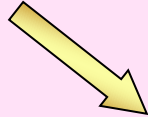
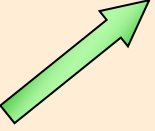
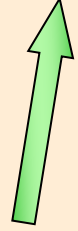
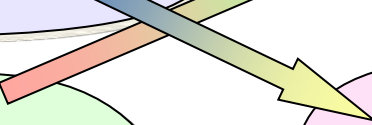
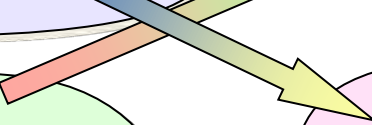
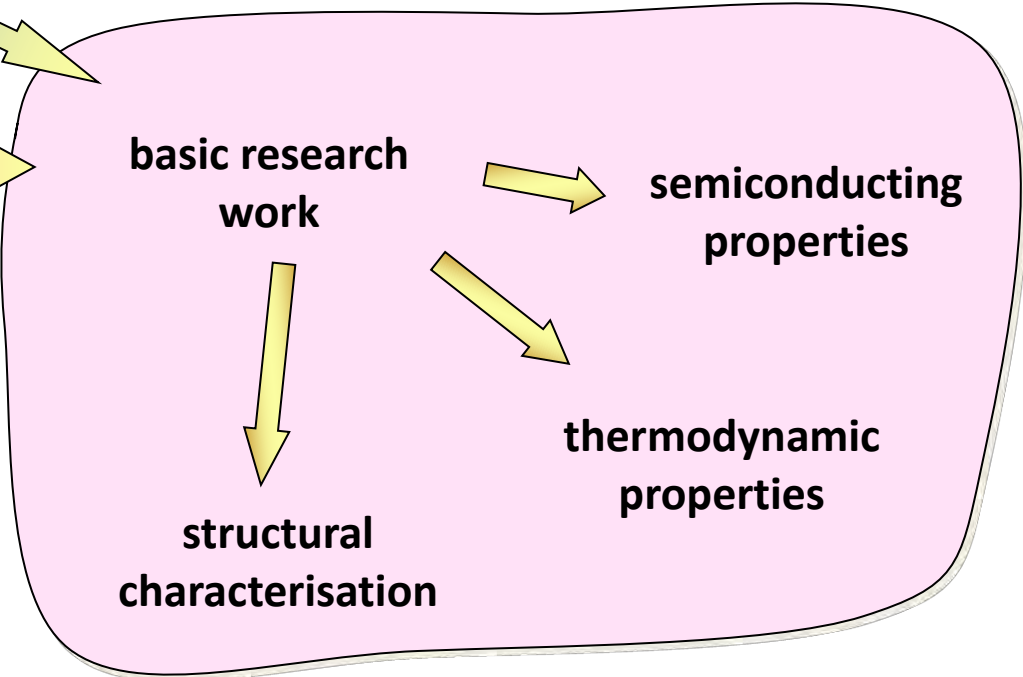
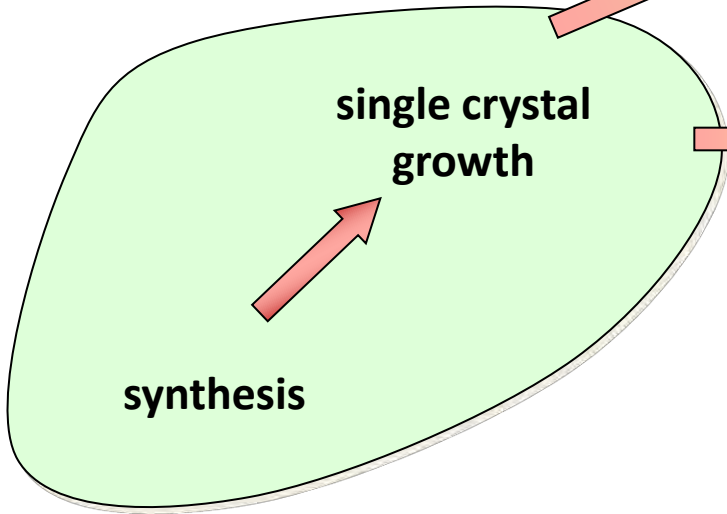
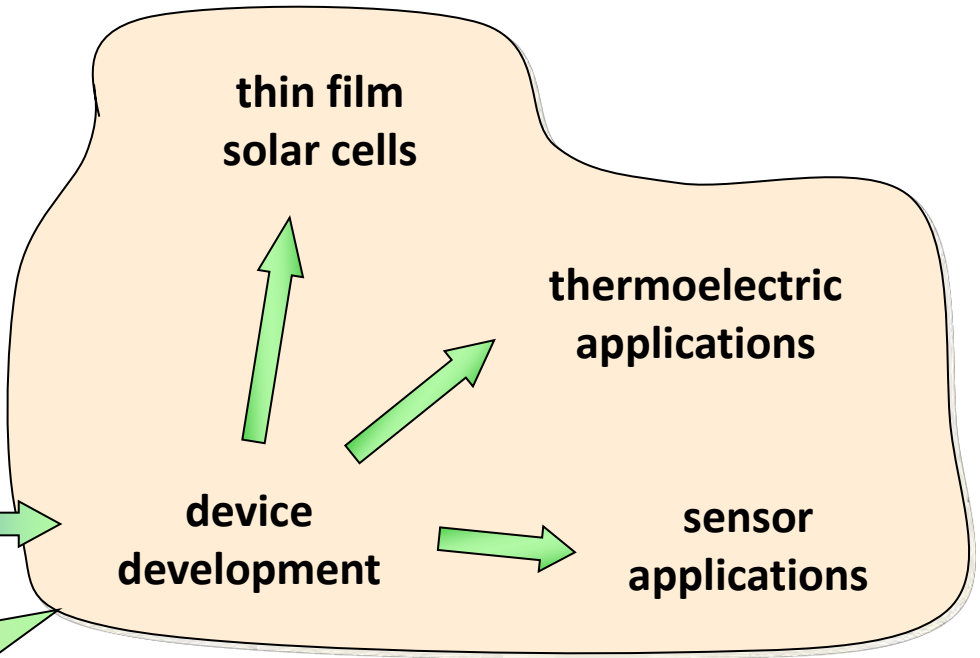
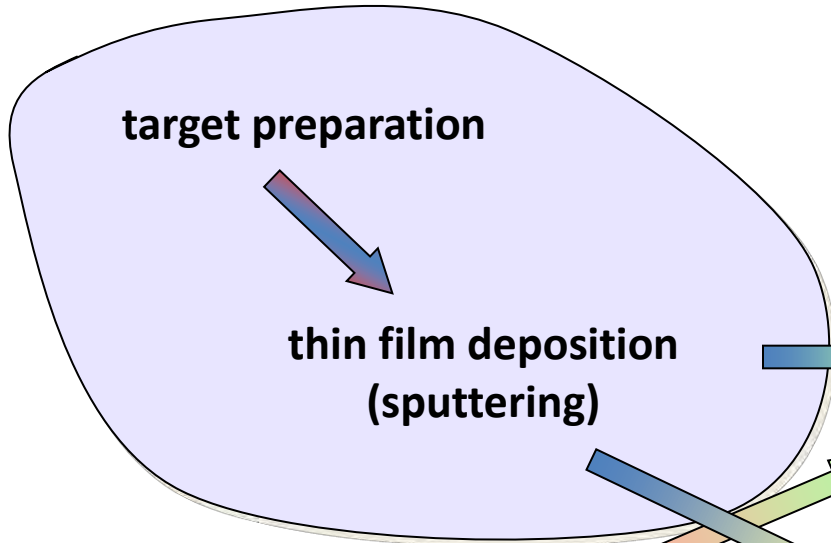
Synthesis of new sulfosalt compounds

0.3 mm



Structure of a sulfosalt thin film solar cell

# Work packages:



# Methods available:

## A. Synthesis and crystal growth

- Quartz ampoule technology
- melt (solution) growth, CVT
- uniaxial hot pressing  
(co-operation with AIT Seibersdorf)

## B. Thin film deposition

cluster sputtering plant for metal layer, sulfosalt layer and TCO deposition

## C. Scanning electron microscope with

- EDX
- EBSD
- $\mu$ -XRF
- CL
- EBIC
- $\mu$ -conductivity

## D. Chemical analysis:

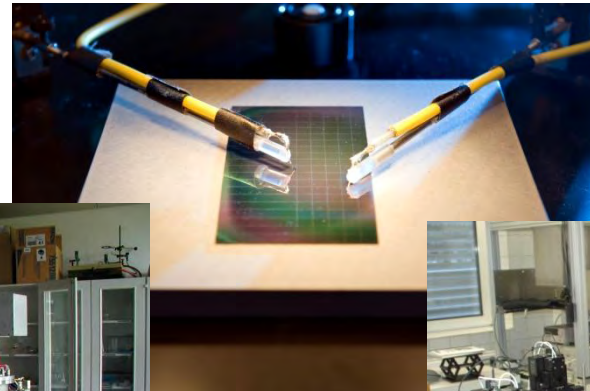
- XRF
- EMPA

## E. Structural analysis

- X-ray single crystal diffractometer
- X-ray powder diffractometer
- X-ray powder diffractometer with high temperature chamber

## F. Physical properties

- Potential-Seebeck microprobe
- Photoacoustic spectroscopy
- UV/Vis/NIR spectrometer
- I-V characteristics (sun simulator)
- conductivity measurements  
(2point- and 4point-probe)



# Results:

4 new sulfosalt phases synthesized

15 new sulfosalt structures resolved

Sulfosalt thin film solar cell realisation

TCO: n-type ZnO:AL and ITO layers with high transmission and electrical conductivity realised

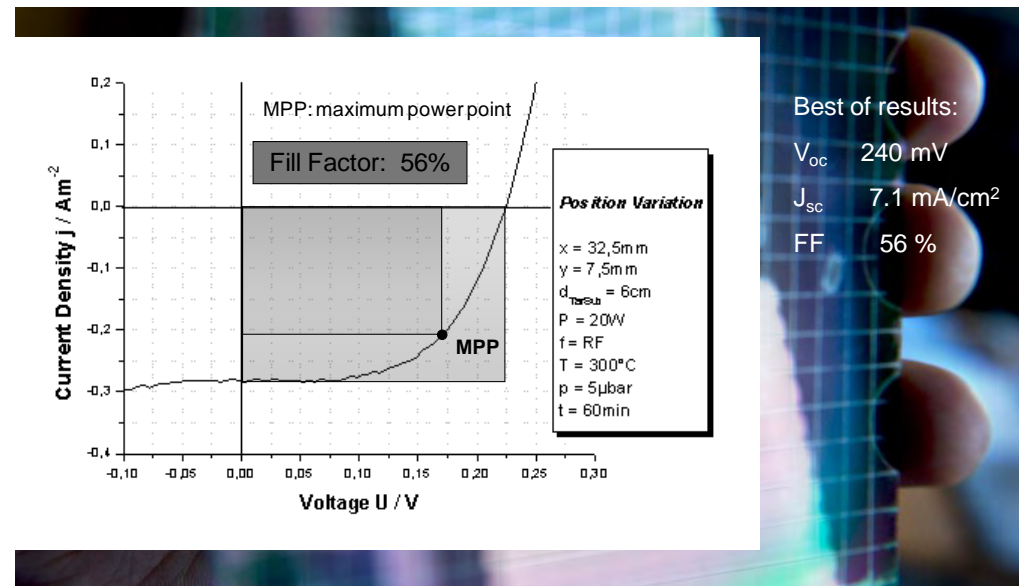
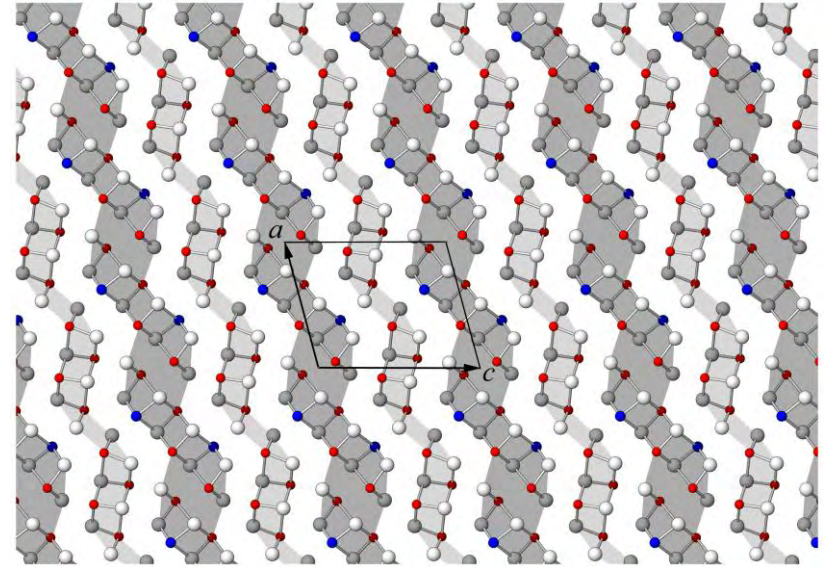
Sulfosalt absorber layers: work on 4 ternary systems and 2 quaternary systems; correlation of deposition parameters and physical properties; first proofs of concept for different material systems

Metallic back contact: parameters for Mo-deposition

Thermoelectric properties

Seebeck coefficients > 400  $\mu\text{V}/\text{K}$

Electrical conductivities > 70 S/cm



## Team:

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Dr. Dan Topa


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TA Gerhard Aigner

Head: Prof. Dr. Herbert Dittrich

## Industrial Co-operation Partners:

***Chemetall***

 Salzburg AG

***SEZ*** 

until 31. 12. 2008