Investigations on novel thermoelectric materials using a high temperature Hall-measurement-setup

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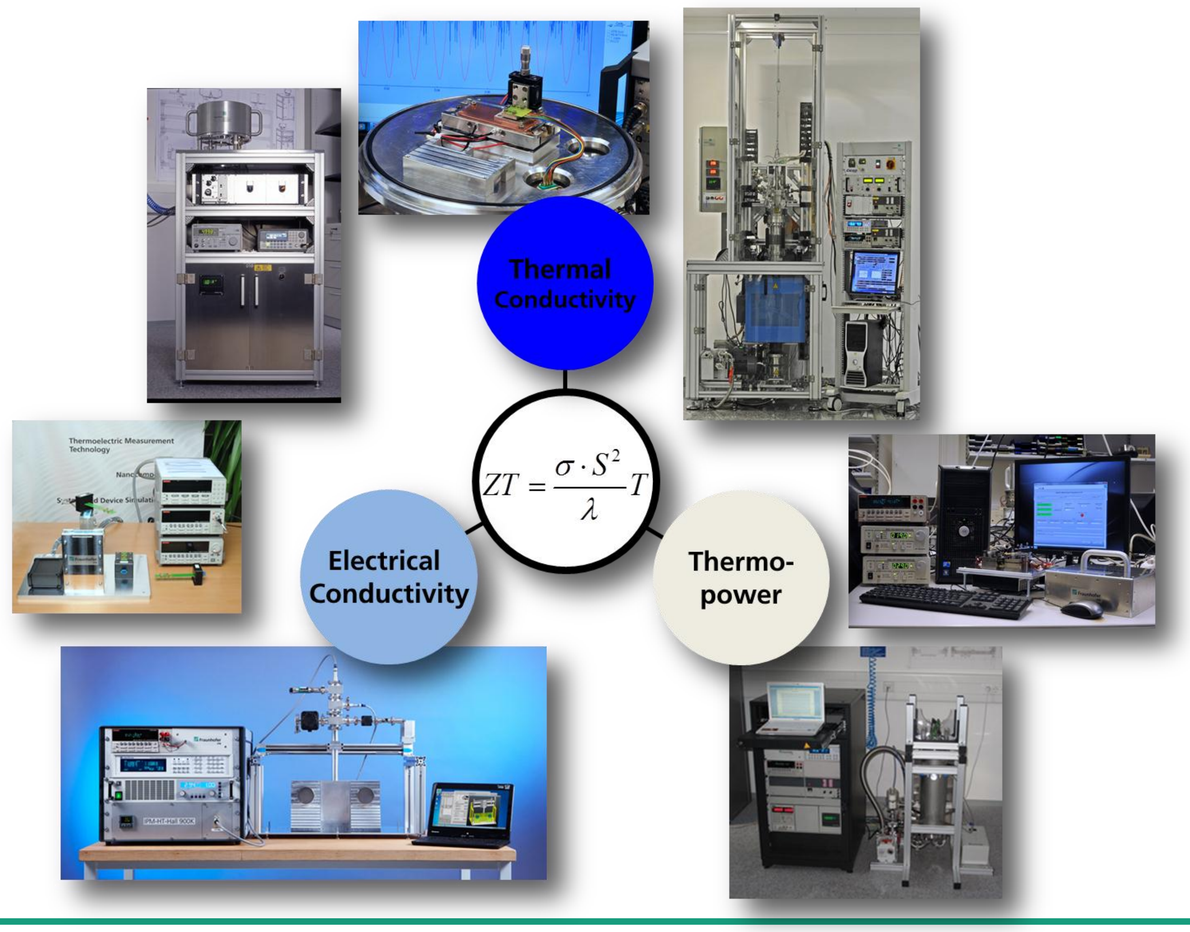
Overview

Parameters measured by Fraunhofer IPM systems

- electrical conductivity
- thermal conductivity
- Seebeck coefficient
- Hall coefficient
- carrier concentration
- carrier mobility
- contact resistance
- module efficiency



Fraunhofer IPM measurement systems

- IPM-SRX: powerfactor measurement, bulk and thin film, van-der-Pauw conductivity
- IPM-3Omega: thin film ZT-meter, thermal conductivity
- IPM-RT-Seebeck: Seebeck coefficient, screening systems
- IPM-Hall-systems: 70K – 900K
- IPM-ZT-Meter: all in one

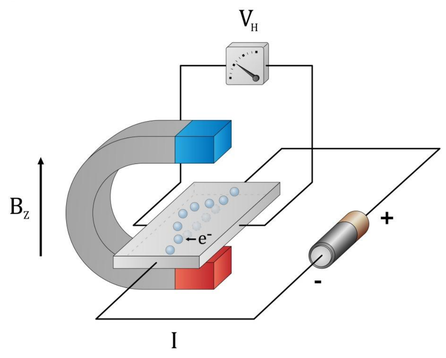
Why Hall measurements?

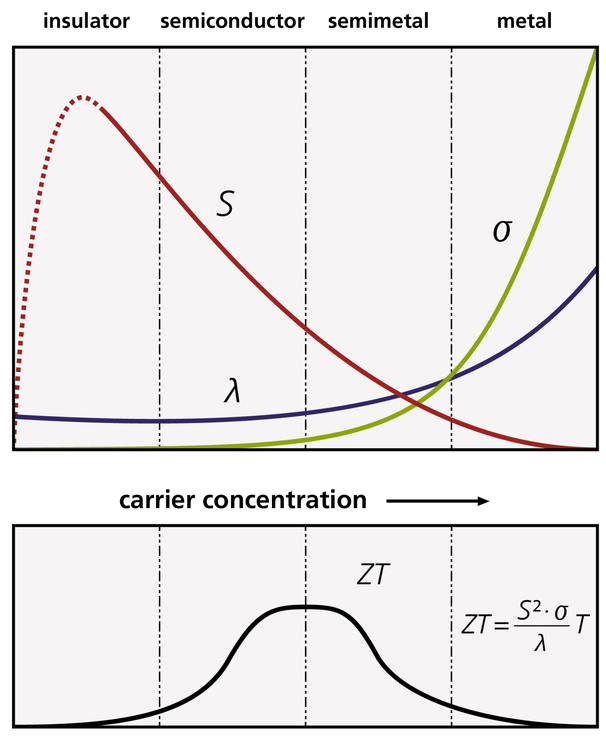
For high ZT

$$S = \frac{8\pi^2 k_b^2}{3eh^2} m^* T \left(\frac{\pi}{3n}\right)^{2/3}$$ high as in semiconductor

$$\sigma = nq\mu = \frac{nq^2\pi}{m^*}$$ high as in metals

$$\lambda = \lambda_l + \lambda_q = \lambda_l + LTnq\mu$$ low as in glass





- All parameters relevant for ZT depend on carrier concentration.
- Measuring carrier concentration is important to optimize TE-materials.
- Carrier concentration may also depends on temperature.
- Modern TE-materials are working at high temperatures over 500°C.

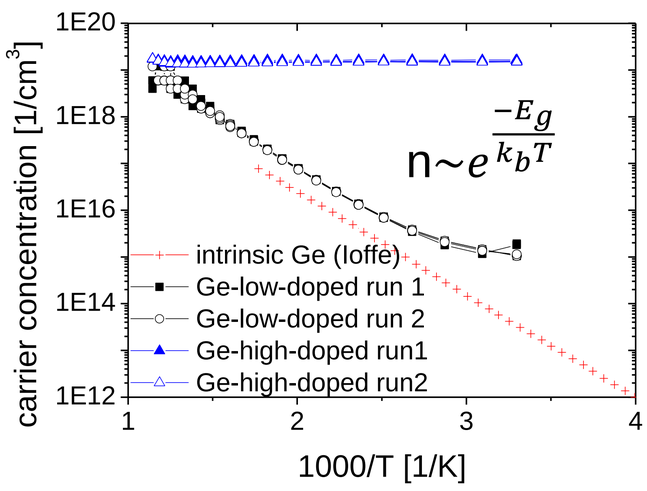
➢ Carrier concentration measurements at high temperature needed for material development.

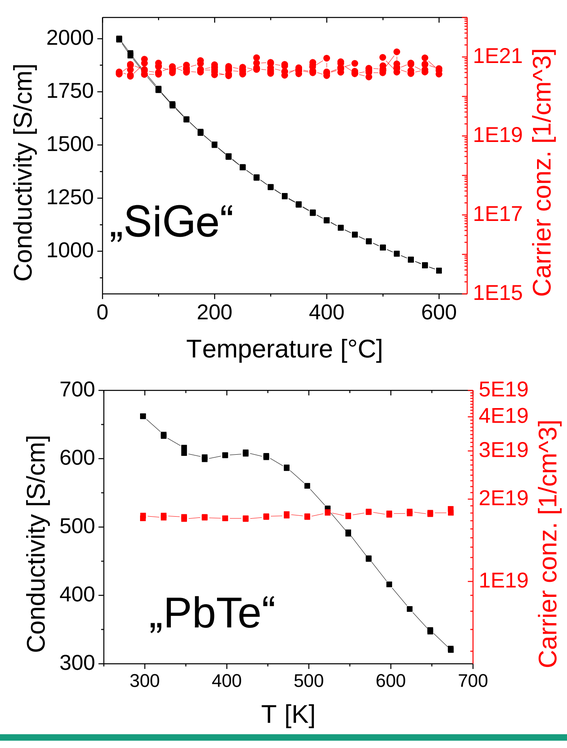
IPM-HT-Hall-system

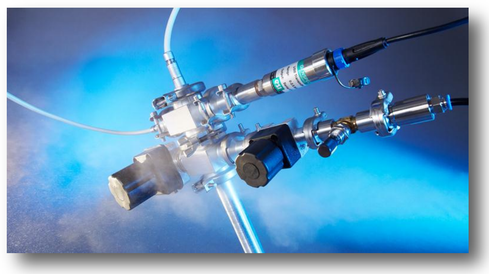
Checking System with different samples

Main aspects

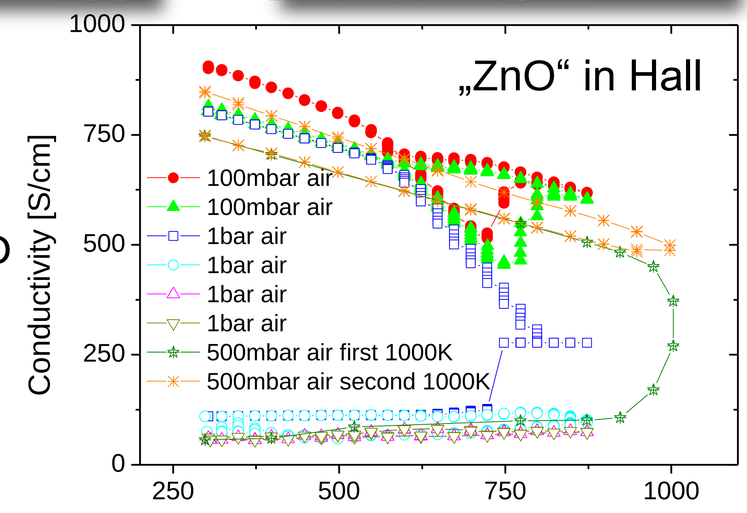
- adjustable atmosphere
- round and square shaped samples from 5-12.5mm
- bulk and thin-film samples
- changeable contact tip material
- temperature range RT - 900K
- typical measurement range:
  - Hall-coefficient: larger 0.1 cm^3/C
  - electrical conductivity: 1 – 10.000 S/cm
  - carrier concentration: up to 10^{22} $1/cm^3$
  - carrier mobility: 0.5 – 500 $cm^2/(Vs)$

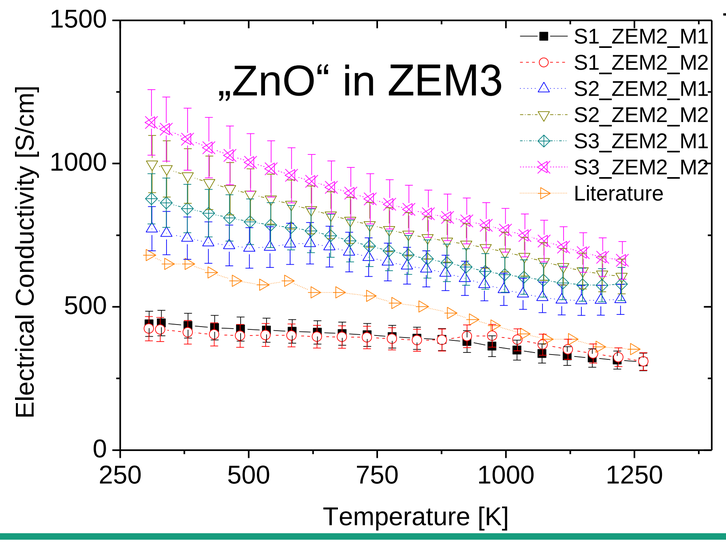






Investigating $Zn_{0.96}Al_{0.02}Ga_{0.02}O$ as published by Ohtaki





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