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

\[ S = \frac{8 \pi k_f^2}{3 e h^2 m^* T} \left( \frac{\pi}{3 m^*} \right)^{2/3} \]

\[ \sigma = n q \mu = n q \frac{\pi}{m^*} \]

\[ \lambda = \lambda_i + \lambda_q = \lambda_i + \lambda T n q \mu \]

- high as in semiconductor
- high as in metals
- 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 depend 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

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 cm²/C
  - electrical conductivity: 1 – 10.000 S/cm
  - carrier concentration: up to 10²² 1/cm³
  - carrier mobility: 0.5 – 500 cm²/(Vs)

Checking System with different samples

Investigating Zn_{0.96}Al_{0.04}Ga_{0.02}O as published by Ohtaki

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