Deutsches Zentrum
DLR für Luft- und Raumfahrt

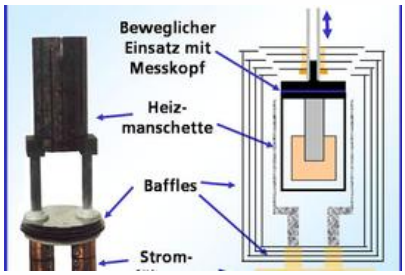
Handout

Automated Hall facility - Determination of electric transport properties

Measured values
- Hall coefficient
- electrical conductivity
- Seebeck coefficient

Description of facility
Fundamental semiconductor properties like concentration and mobility of charge carriers (electrons, holes) provide information for application-oriented materials optimisation. An optimal magnitude of the carrier density has to be adjusted to achieve the maximal thermoelectric figure of merit of semiconductors. In the range beneath ambient temperature essential solid-state physical processes become detectable – mechanism of charge carrier scattering, temperature dependent excitation processes of conduction electrons, the shape of the energy distribution of carriers, as well as special phenomena such as hopping conduction, phonon drag or polaron conductivity. They substantially govern charge and heat transport in highly doped semiconductors and are thus highly meaningful for thermoelectric transport processes.

The carrier mobility is a central quantity for the estimation of a materials' maximal possible thermoelectric figure of merit and thus for its potential in a thermoelectric application. It can be determined directly by the measurement of the Hall coefficient and the electrical conductivity and allows – based on a single measurement on a non-optimised sample – for a prognosis on the limits of the application-relevant properties of a thermoelectric material, already prior to a laborious experimental optimisation of carrier concentration by variation of doping concentration. The Hall equipment of the institute allows for determination of transport properties versus temperature (Hall coefficient, electrical conductivity, Seebeck coefficient) in a low magnetic field (up to 1 T) ranging from lowest up to very high temperatures (10 K–1200 K). It is equipped with a movable magnet unit which can be positioned to either of two vacuum recipients with measuring heads developed at DLR: a module for cryogenic measurement of Hall coefficient and electrical conductivity (10 K–330 K) and a new unit for high temperature measurement of Hall and Seebeck coefficients as well as of electric conductivity (ambient temperature–1200 K; under completion).



Application
- Achievement of the maxomal thermoelectric figure of merit of semiconductors
- Estimation of a materials´maximal possible thermoelectric figure
- Measurement of the Hall coefficient and the electrical conductivity

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This handout, and cross-references to related measurement techiques and facilities are available at: http://messtec.dlr.de/link-288-en.

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