Our Expertise

- Measurement of thermophysical properties by conventional and optical methods over broad ranges of temperature, pressure, and composition with low uncertainties
- Development of measurement methods and systems
- Inquiry and review of thermophysical properties
- Development and review of correlations and prediction schemes for thermophysical properties
- Theoretical determination of thermophysical properties by molecular dynamics (MD) simulations

Your Benefits

- Our state-of-the-art measurement methods which are continuously further developed
- Our experience in the measurement, prediction, and evaluation of thermophysical properties
- Our activity on the cutting edge of thermophysical properties research
- Our interdisciplinary team of researchers
- Our contact to national and international experts in the fields of measurement and theoretical determination of thermophysical properties

Contact:

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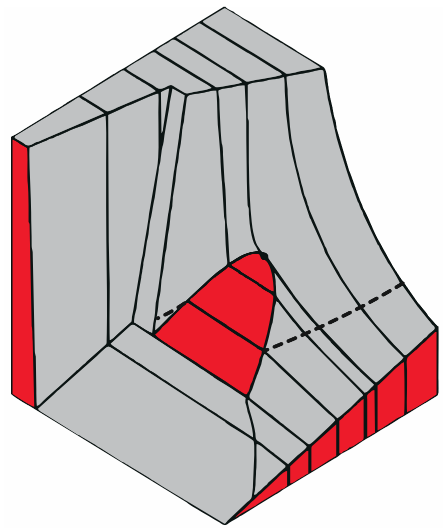
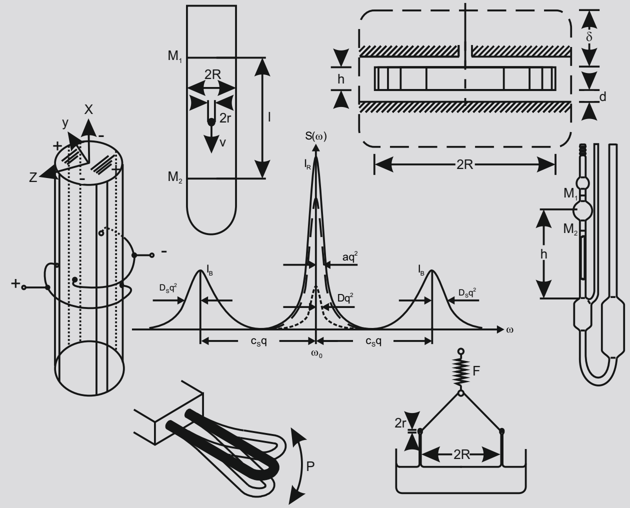
FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG
TECHNISCHE FAKULTÄT

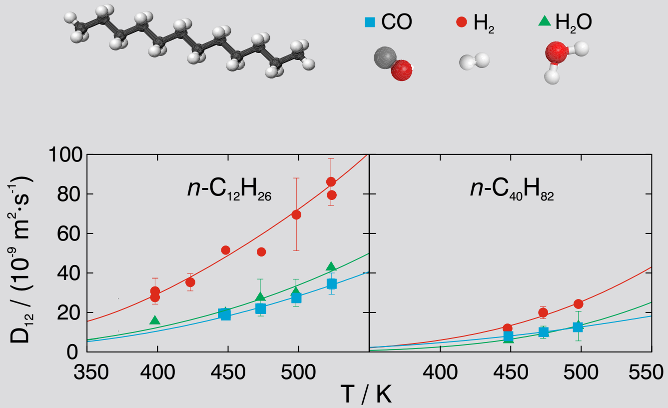
THERMOPHYSICAL PROPERTIES



Friedrich-Alexander-University Erlangen-Nürnberg (FAU)

Institute of Advanced Optical Technologies – Thermophysical Properties





Institute

The Institute of Advanced Optical Technologies – Thermophysical Properties (AOT–TP) headed by Prof. Dr.-Ing. habil. Andreas Paul Fröba has been established in 2015 as an independent unit within the Department of Chemical and Biological Engineering (CBI) and is located at the Erlangen Graduate School in Advanced Optical Technologies (SAOT) of the Friedrich-Alexander-University Erlangen-Nürnberg (FAU). The institute and its staff members focus on the development and application of various conventional and optical methods for the accurate determination of thermophysical properties of fluids of interest for chemical and energy engineering. Besides the experimental approach, the expertise of the institute also includes the theoretical calculation of thermophysical properties based on molecular dynamics (MD) simulations as well as the development of prediction schemes for engineering practice.

Importance and Types of Thermophysical Properties

The knowledge of the thermophysical properties of fluids is important in nearly every area of scientific and technological interest. They serve for the investigation of, e.g., structure-property relationships in science and are essential information for a successful design of efficient apparatus and processes for industrial purposes.

The most common thermophysical properties can be classified as either equilibrium or transport properties. The first category includes pressure-volume-temperature or density data and numerous derived properties which determine the state change of a fluid resulting from an external stimulus. Transport properties such as thermal conductivity, thermal diffusivity, mass diffusivity, and viscosity describe the rate of change in the state of a fluid as a result of the variation of external conditions.

Methods, Properties, Ranges, Uncertainties

Dependent on specific issues such as the fluid characteristics, the thermodynamic state, and the desired uncertainty, the following measurement methods can be applied. The given numbers represent achievable thermodynamic states as well as typical ranges and uncertainties for the measured properties.

- **Dynamic Light Scattering (DLS) from Bulk of Fluids**
  (−40 to 300)°C, up to 200 bar

thermal diffusivity	(0 to 1×10^{-7}) $m^2 \cdot s^{-1}$	< 2%
diffusion coefficients	(0 to 1×10^{-7}) $m^2 \cdot s^{-1}$	< 10%
speed of sound	(0 to 1200) $m \cdot s^{-1}$	< 0.5%
sound attenuation	(1×10^{-7} to 1×10^{-5}) $m^2 \cdot s^{-1}$	< 10%
dynamic viscosity	mPa·s to Pa·s	< 2%
particle/droplet size	nm to μm	< 5%
Landau-Placzek ratio	about 1 to 100	< 10%

- **Surface Light Scattering (SLS)**
  (−40 to 300)°C, up to 200 bar

dynamic viscosity	μPa·s to kPa·s	< 2%
surface/interfacial tension	< 100 $mN \cdot m^{-1}$	< 2%

- **Holographic Interferometry in a Loschmidt Cell for Gases**
  (10 to 80)°C, up to 10 bar

diffusion coefficients	(1×10^{-6} to 1×10^{-4}) $m^2 \cdot s^{-1}$	< 3%

- **Parallel-Plate Method for Fluids, Solids, and Heterogeneous Systems (layered materials, pastes, etc.)**
  (−40 to 120)°C, up to 2 bar

thermal conductivity	(0.01 to 10) $W \cdot m^{-1} \cdot s^{-1}$	< 5%

  + effective thermal conductivity or overall heat transfer coefficients for heterogeneous systems

- **Vibrating Tube Densimetry**

(0 to 100)°C, up to 10 bar		
density	(0 to 3) $g \cdot cm^{-3}$	< 0.005%
(−10 to 200)°C, up to 500 bar		
density	(0 to 3) $g \cdot cm^{-3}$	< 0.05%

- **Rotational and Oscillatory Rheometry**

(−30 to 200)°C, atmospheric pressure		
dynamic viscosity	0.5 mPa·s to Pa·s	< 5%
(20 to 300)°C, up to 450 bar		
dynamic viscosity	10 mPa·s to 100 Pa·s	< 5%

  + rheological tests

- **Capillary Viscometry**
  (25 to 100)°C, atmospheric pressure

kinematic viscosity	(0.8 to 300) $mm^2 \cdot s^{-1}$	< 2%

- **Pendant and Sessile Drop Methods**
  (25 to 110)°C, up to 12 bar for variable atmospheres

surface/interfacial tension	(5 to 100) $mN \cdot m^{-1}$	< 3%
contact angle	(10 to 170)°	< 1°
surface free energy	(10 to 100) $mN \cdot m^{-1}$	< 10%

  + optical analysis of dynamic wetting behavior

- **Refractometry**

Abbe method: (5 to 120)°C, atmospheric pressure		
refractive index	1.3 to 1.7	0.0005
Beam displacement method: (−40 to 300)°C, up to 200 bar		
refractive index	1.0 to 1.6	0.5%

Furthermore, we can provide access to further measurement methods and thermophysical properties via our national and international cooperation partners.