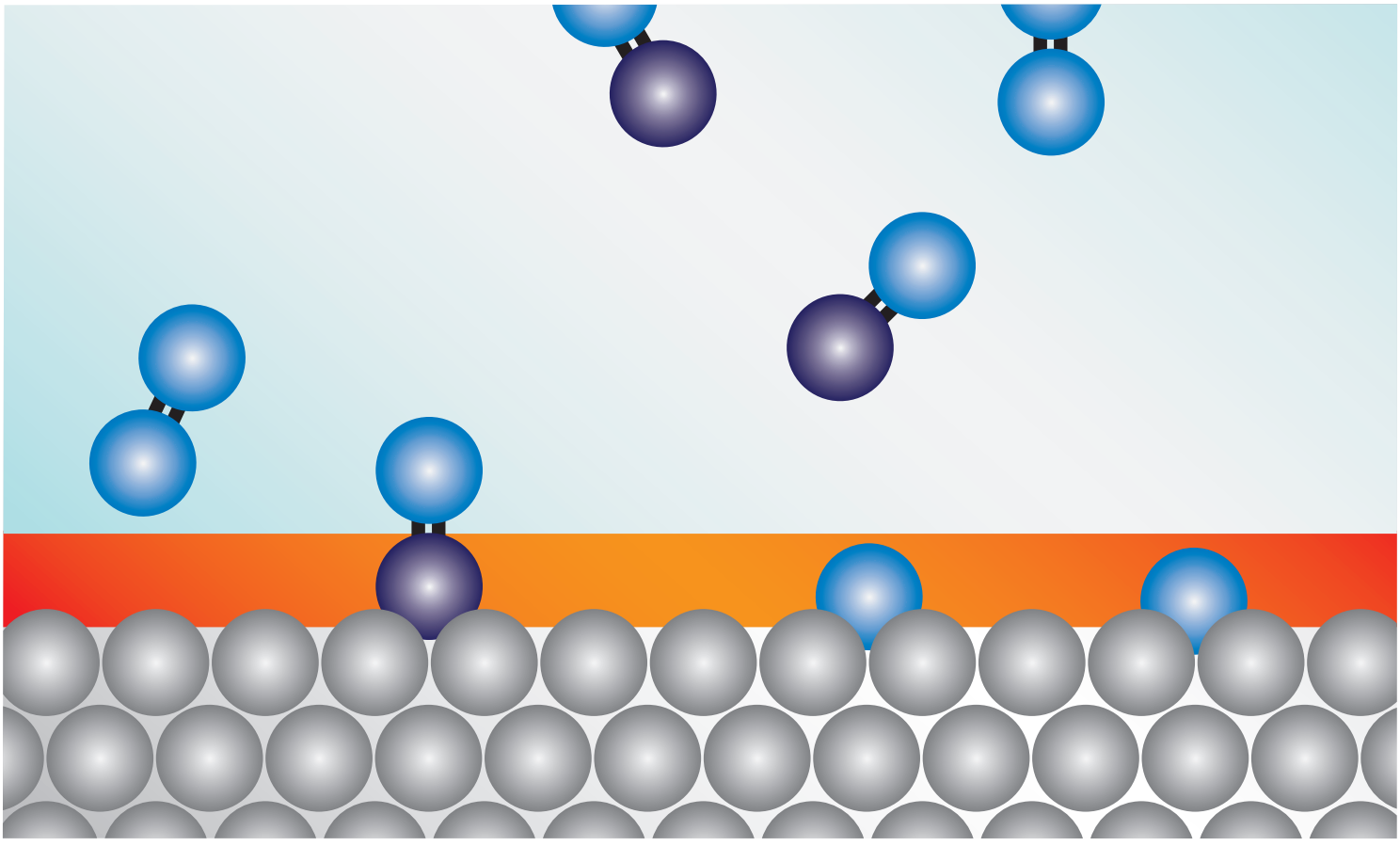
LINSEIS

THERMAL ANALYSIS

GRAVIMETRIC SORPTION ANALYZERS

GSA PT 10
GSA PT 100
GSA PT 1000



Since 1957 LINSEIS Corporation has been delivering outstanding service, know how and leading innovative products in the field of thermal analysis and thermo physical properties.

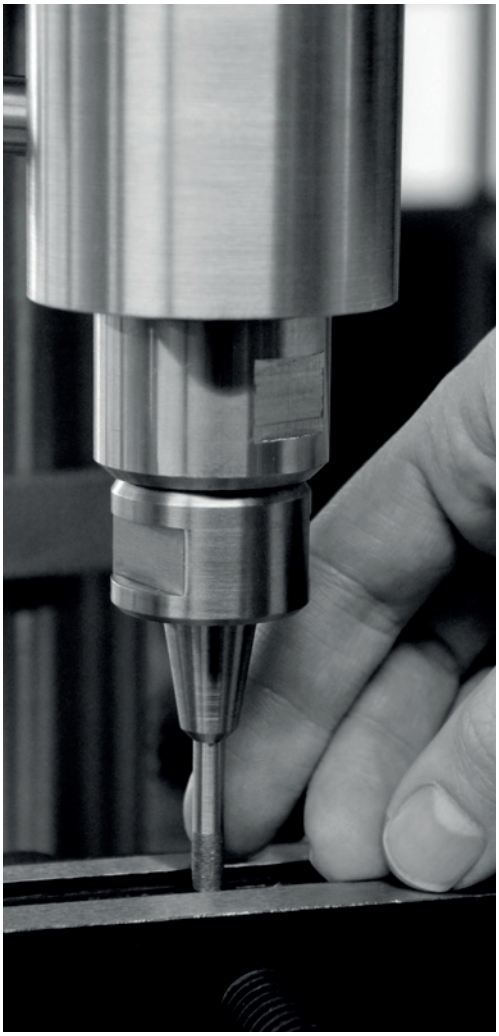
Customer satisfaction, innovation, flexibility and high quality are what LINSEIS represents. Thanks to these fundamentals, our company enjoys an exceptional reputation among the leading scientific and industrial organizations. LINSEIS has been offering highly innovative benchmark products for many years.

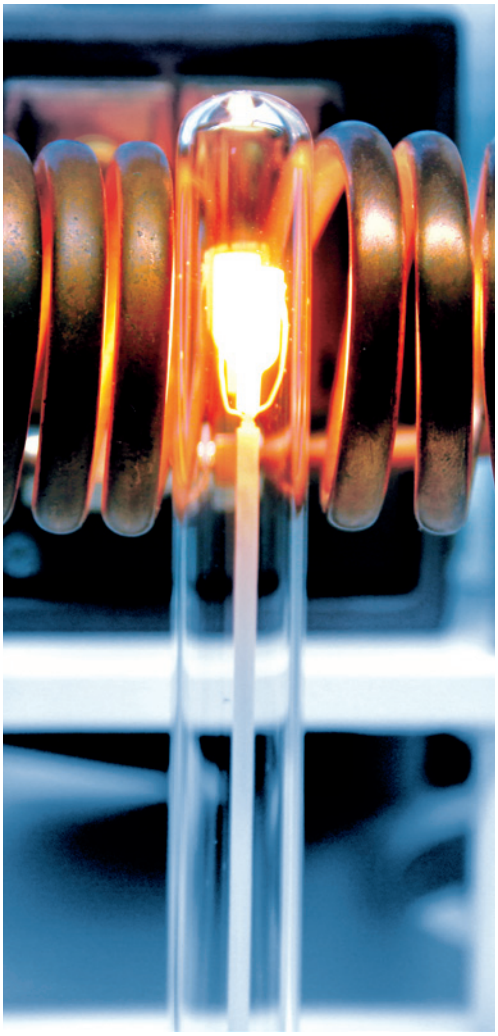
The LINSEIS business unit of thermal analysis is involved in the complete range of thermo analytical equipment for R&D as well as quality control. We support applications in sectors such as polymers, chemical industry, inorganic building materials and environmental analytics. In addition, thermo physical properties of solids, liquids and melts can be analyzed.

LINSEIS provides technological leadership. We develop and manufacture thermo analytic and thermo physical testing equipment to the highest standards and precision. Due to our innovative drive and precision, we are a leading manufacturer of thermal Analysis equipment.

The development of thermo analytical testing machines requires significant research and a high degree of precision. LINSEIS Corp. invests in this research to the benefit of our customers.

Claus Linseis
Managing Director





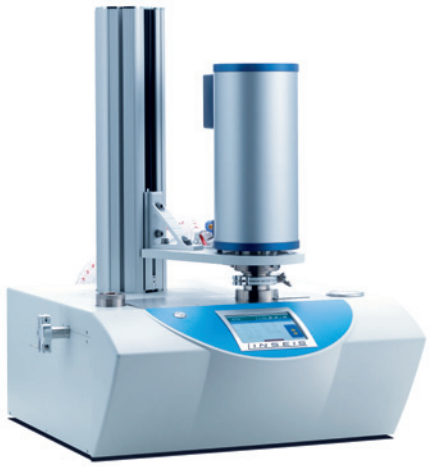
German engineering

The strive for the best due diligence and accountability is part of our DNA. Our history is affected by German engineering and strict quality control.

Innovation

We want to deliver the latest and best technology for our customers. LINSEIS continues to innovate and enhance our existing thermal analyzers. Our goal is constantly develop new technologies to enable continued discovery in science.

GSA – GRAVIMETRIC SORPTION ANALYZERS



GSA PT 10

GSA PT 100

Chemisorption/Physisorption (UHV to 1000 bar)

Adsorption Isotherms (BET Surface Analysis)

TPD, TPO, TPR measurements (-196 to 1800°C)

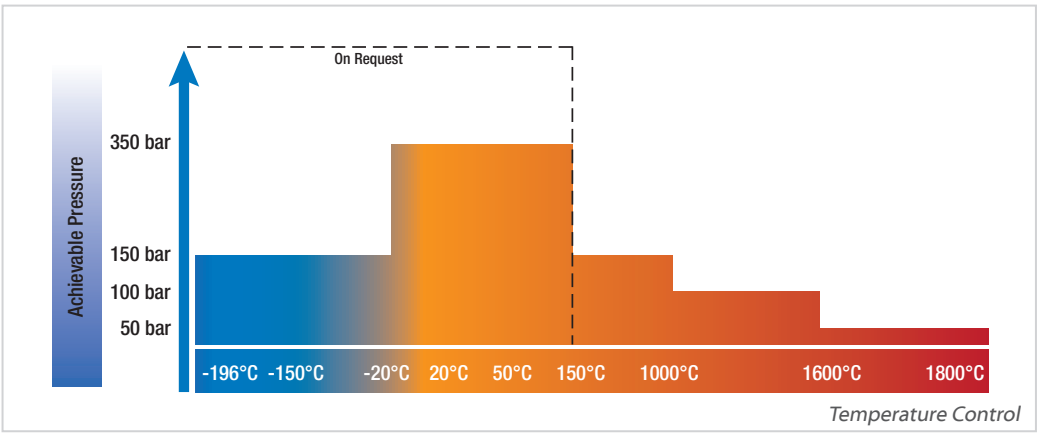
Sorption Enthalpies (Simultaneous TG/DSC-sensor)

In-situ Gas Analysis (FTIR, Raman, ELIF)

Corrosive Atmospheres Magnetic Suspension Balance

GSA PT 1000

The adsorption or desorption of various gases by materials like catalysts or porous structures is one special, but very frequently asked application on thermo-balances. In general, there are two ways of monitoring adsorption and desorption, the volumetric sorption, where a definite amount of gas is brought into a sample chamber and the pressure change provides the information, and the gravimetric sorption, where the mass change of the sample is analyzed. With our thermo-balance series, we use the gravimetric sorption setup which is possible due to our high resolution balance cells that can monitor very small mass changes over a broad pressure range. This enables the instrument to analyze precisely the adsorption and desorption behavior of various materials in a temperature range from -196°C to 1800°C and a pressure range of 0.01 mbar to 300 bars.



Temperature Control

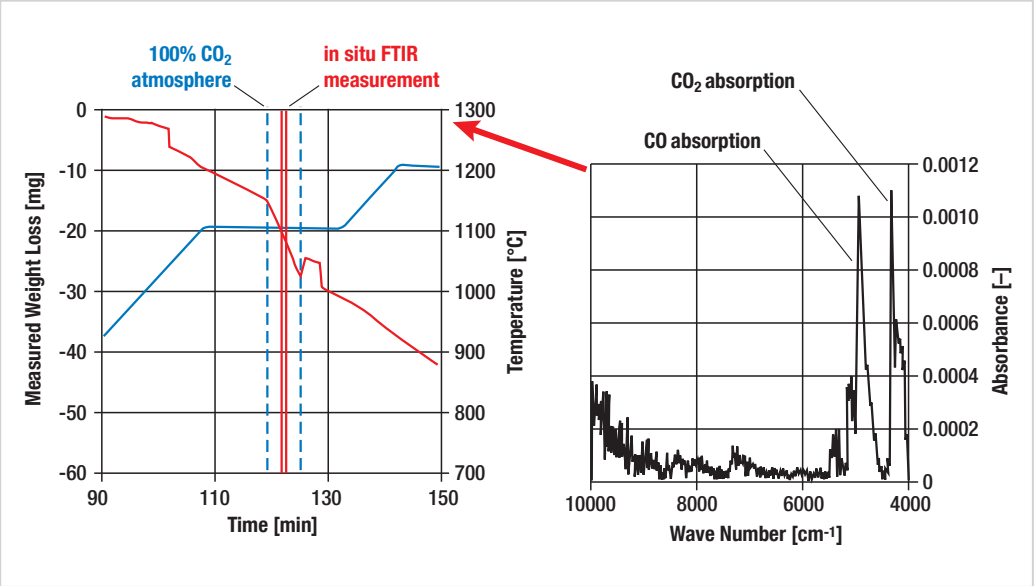
There are a lot of advantages coming up with gravimetric sorption: If a DSC measurement system is used, there is also the possibility to detect the sorption enthalpy during the measurement, what can provide very interesting information about the adsorption process as well. Another point is the flexibility in measurement systems and sample volumes that can be some milligram or even some gram using different sample holders.

The gravimetric sorption is the easier, faster and more flexible method to get information about gas adsorption, even if the accuracy of volumetric sorption can't be reached so far.

The following devices can be used for gravimetric sorption analysis:

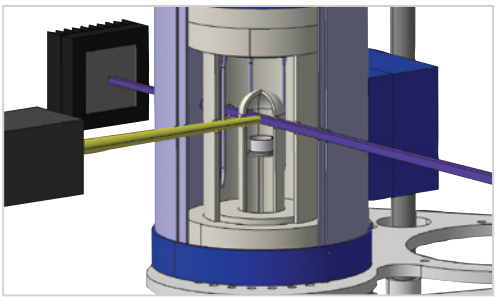
- GSA PT 10 (STA PT 1600)
- GSA PT 100 (MSB)
- GSA PT 1000 (STA HP)

FTIR COUPLING



All LINSEIS gravimetric sorption systems can be coupled with additional analyzing tools like FTIR. In the experiment charcoal was gasified in CO_2 atmosphere. Therefore the coal sample was placed in the instrument and the temperature at constant pressure of CO_2 was increased. During an isothermal segment at 1100°C, a huge mass loss could be observed, which symbolizes the gasification of the bound carbon (following the equation $C+CO_2 \longrightarrow 2\ CO$).

The graphic shows the in-situ FTIR measurement during gasification of coal in a TGA system. (Sample temperature: 1100°C, pure CO_2 atmosphere at a gas flow rate of 20 ml/min at 273K, 0.013 bars) The FTIR measurement was taken for 30s during the main mass loss step. The CO and CO_2 signals can be clearly seen in the IR spectrum, proving the release of CO gas during the mass loss step.



SPECIFICATIONS

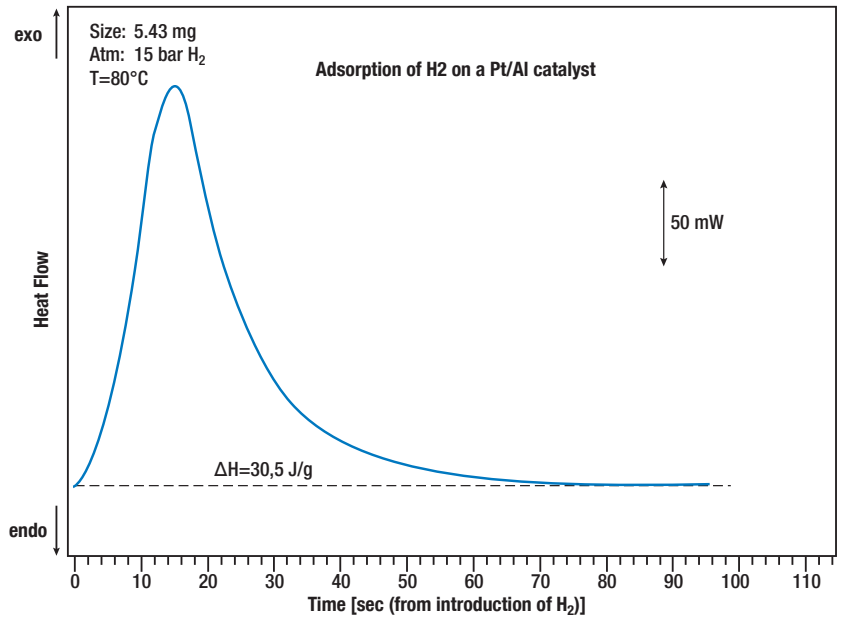
	GSA PT10
Temperature range	-150 bis 500/700/1000°C RT bis 1400/1600°C
Heating rates	0.01 up to 100°C/min
Sample weight	5 / 25 / 35 g (higher sample weights on request)
Resolution	0.025 / 0.1 µg
Vacuum	10^{-5} mbar
Pressure	optional 5/10 bar
Detector	TG, TG – DTA,
Sensor	(E/K/S/B)
Electronics	integrated
Interface	USB

	GSA PT100
Temperature range	-170°C up to 1250/1400/1600/1800°C max. 150 bar (different Versions)
Max. pressure	300 bar on request
Vacuum	10^{-4} mbar
TGA	
Max. sample mass	2/15g (higher sample weights on request)
Resolution	0.1 µg
DSC	
DSC resolution	0,3/0,4/1 µW
DSC sensors	E, K, S, C
Options	Pressure controlable Gas Mixing System (MFC´s)
Atmospheres	inert, oxid.*, red., vac

	GSA PT1000
Temperature & pressure range	RT up to 1100°C and max. 150 bar RT up tp 1400/1800°C and max. 50 bar
Pressure range	UHV – Ultra High Vacuum to 150 bar
Probengewicht	10 g (standard balance)
Resolution	1 ug
Evolved Gas Analysis	MS/FTIR possible
Options	Special custom versions can be realized

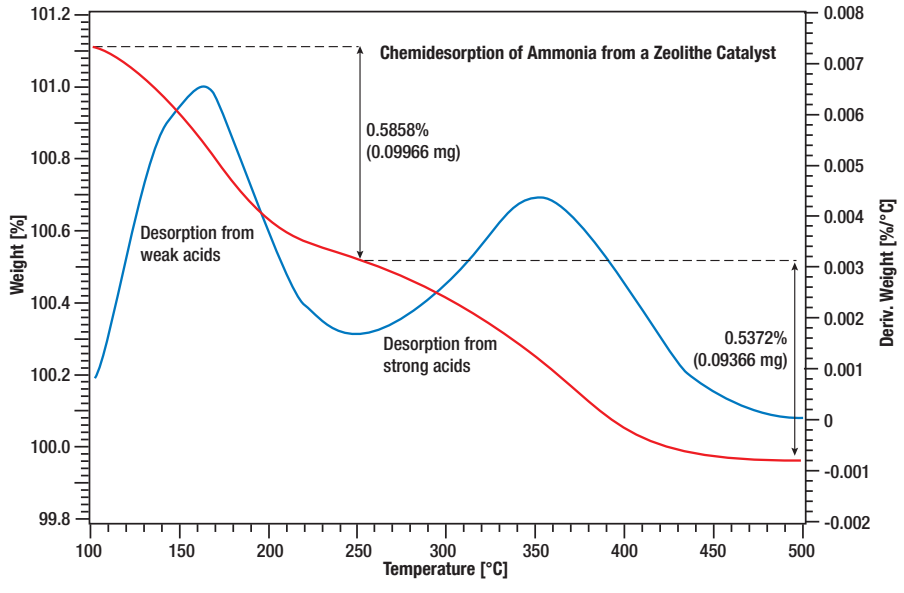
APPLICATIONS

Fast and Easy determination of Sorption Heats



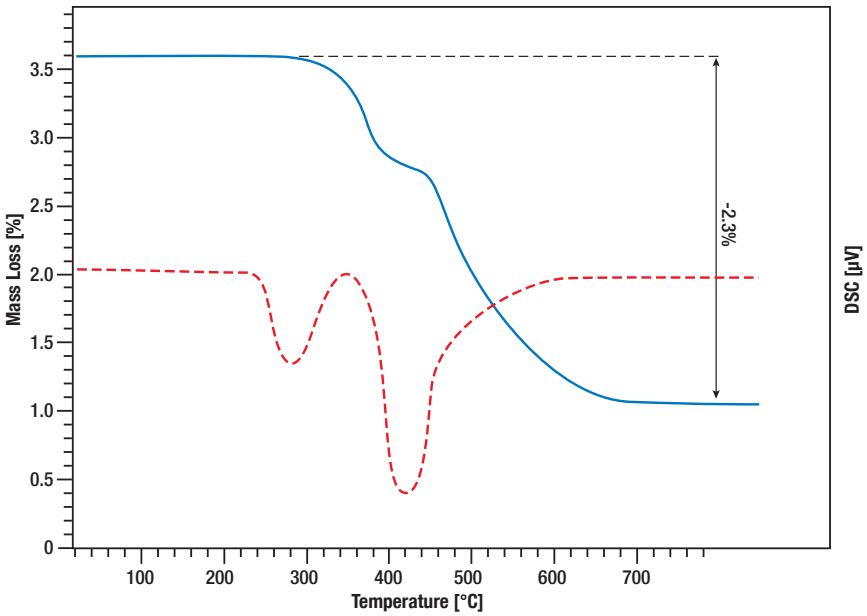
The measurement of sorption, oxidation or reduction heats of catalysts performed with volumetric methods are normally very time-consuming and need many hours. The LINSEIS Gravimetric Sorption Analyzer STA HP, which measures both weight change and DSC-signal, provides a much faster alternative. Within 15 minutes or less the sorption heats can be measured. Chemisorption and catalytic oxidation or reduction are exothermic reactions. The heat involved can be easily monitored with the integrated DSC- sensor of the LINSEIS STA HP. The figure above shows the DSC- signal of the adsorption of Hydrogen on a Pt/Al catalyst at a pressure of 15 bar and a temperature of 80°C. The evolved heat is 30,5 J/g.

TPD, TPO and TPR measurements



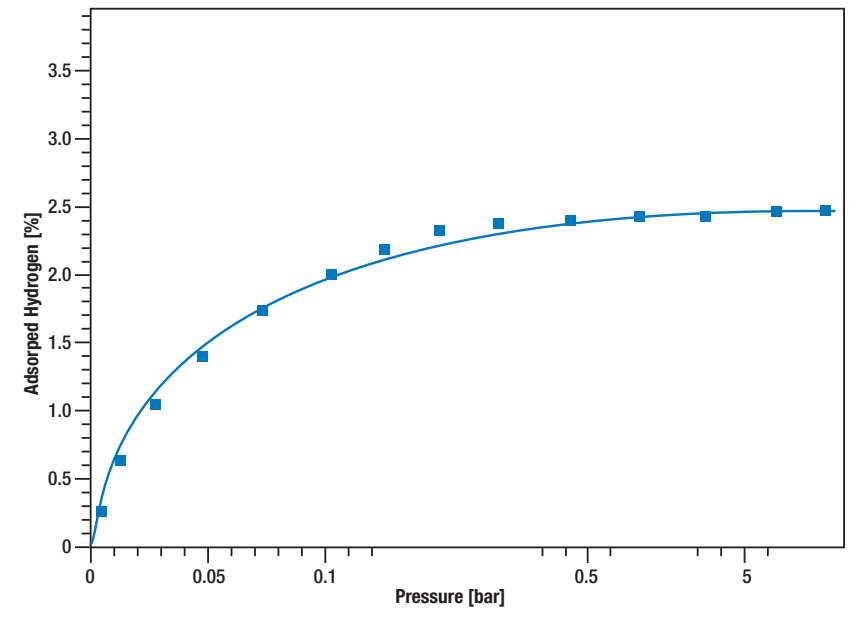
The distribution and relative strength of acid sites in zeolithes are important indicators of its catalytic properties. The acidity of zeolithes can be accurately measured with the temperature programmed desorption (TPD) of a base from the zeolithe surface. The Linseis gravimetric Sorption Analyzers are useful tools for characterizing TPD, TPO or TPR profiles. The figure above shows the chemidesorption of ammonia from a zeolithe catalyst surface. Weakly bound ammonia molecules are desorped between 100 and 250 °C. Between 260 and 500 °C strongly bound ammonia is desorped. The amounts of desorped ammonia can be quantitatively measured, i.e. it is possible to quantitatively identify the number of strong and weak acid sites present in the sample.

Desorption of Hydrogen on TiH_2



In this application example, desorption of hydrogen of Titanium hydride was monitored. Titanium hydride is a common used hydrogen resource for controlled release of hydrogen in various reactions. To get an idea what amount of hydrogen is released at what temperature, desorption was studied using a LINSEIS STA PT1600 system. TG and DSC signal were measured from RT to 800°C while the sample was heated linear in Argon atmosphere with 10K/min. Between 300°C and 600°C, there is a two-step mass loss of 2.3% in total which means the complete amount of bound hydrogen is released in that process. The DSC curve shows the corresponding Desorption peaks.

Hydrogen adsorption on titanium at 700°C



In the current research on batteries and energy storage, the possibility of hydrogen of various materials storage is investigated very frequently. Hydrogen can be used as energy carrier that could be created and stored and then released when its needed. However, hydrogen is a very small, highly mobile molecule that shows high diffusion rates through any material. Therefore, the storage is a huge issue. In this measurement, the storage capabilities of hydrogen on a titanium alloy were tested at different pressures. The diagram shows that the amount of bound hydrogen (that can be detected by mass increase of the sample) increases over pressure until a plateau is reached at around 1 bar. This is where the material is saturated, carrying around 2.5 mass percent hydrogen.

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