The NETZSCH High-Temperature Properties Series

Knowledge of the thermal behavior is critical to material development and design in every modern industry.

Accurate and efficient measurement of the thermophysical properties, however, requires state-of-the-art instrumentation such as that produced by NETZSCH.

The DSC 404 C *Pegasus*®, LFA 427, LFA 457, DIL 402 C/PC, STA 409 PC, STA 449 C, TCT 426 and HFM 436 form the core of the NETZSCH Thermophysical Properties Series instruments. Properties such as thermal diffusivity, thermal conductivity, specific heat, transformation, enthalpies and temperatures, linear and volumetric thermal expansion, bulk density, mass change, etc. can be quickly and accurately determined using these instruments.

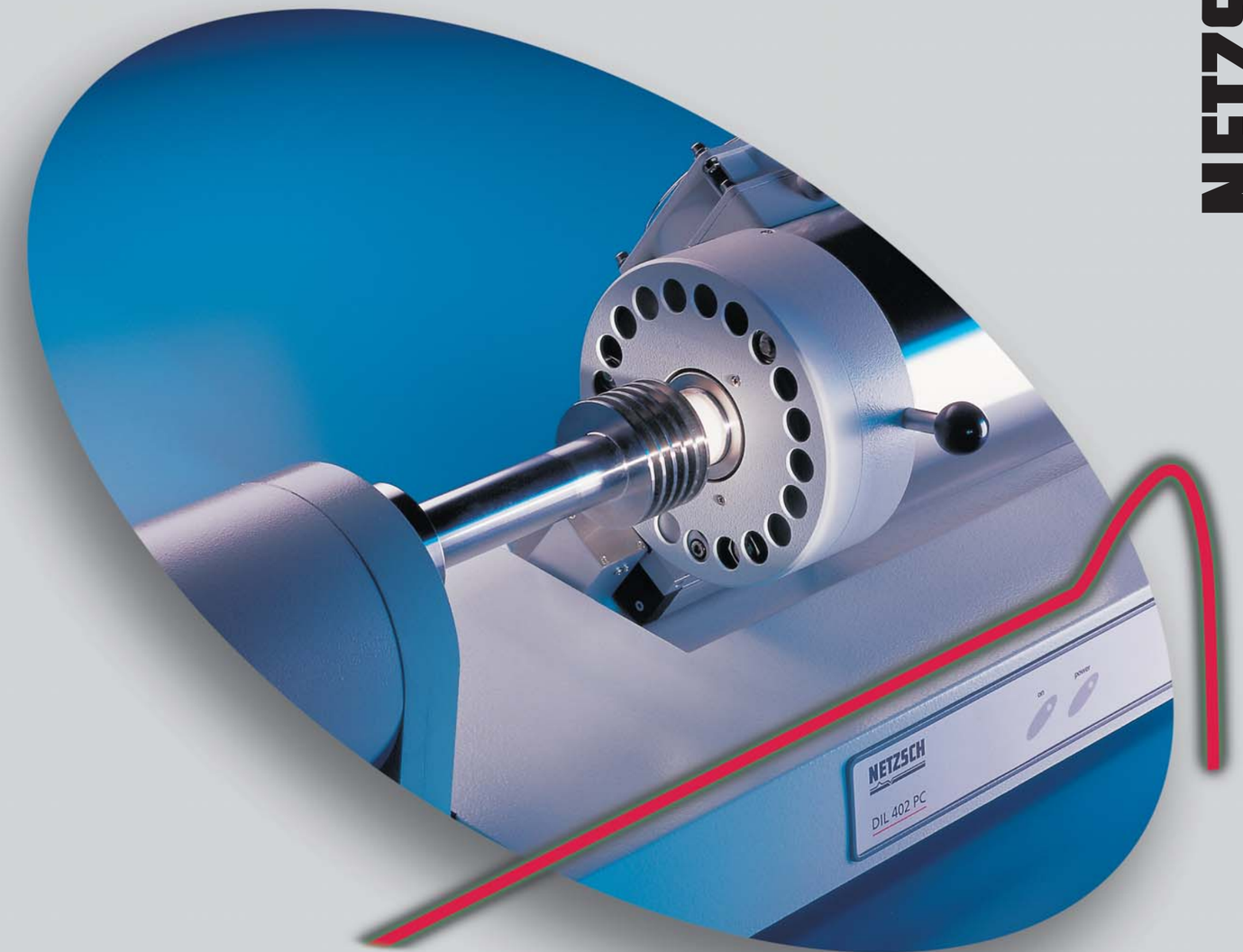

STA 409 PC *Luxx*®


DTA 404 PC *Eos*


GST 420 PC

PC Series Instruments

The DIL 402 PC is part of the NETZSCH PC product line, specially tailored to the needs of glass and ceramic industries. This additionally includes the Simultaneous Thermal Analyzer STA 409 PC *Luxx*® (measurement of mass changes and transformation energetics), the DTA 404 PC Eos, the Glaze Stress Tester GST 420 PC and Bending Strength Tester BST 401. Please refer to the relevant brochures.



NETZSCH

NGB · DIL 402 PC · E · 2000 · 1106 · LH

Leading Thermal Analysis.

DIL 402 PC

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Dilatometer DIL 402 PC

Thermoanalytical methods are widely used in all fields of materials characterization. Especially in the areas of ceramics and glasses, thermal methods such as pushrod dilatometry yield crucial information for the production of the materials and for their later application.

Pushrod dilatometry is a method for determination of dimensional changes versus temperature or time when the sample undergoes a controlled temperature program. The specific materials properties gathered from this, are as follows:

Analysis of

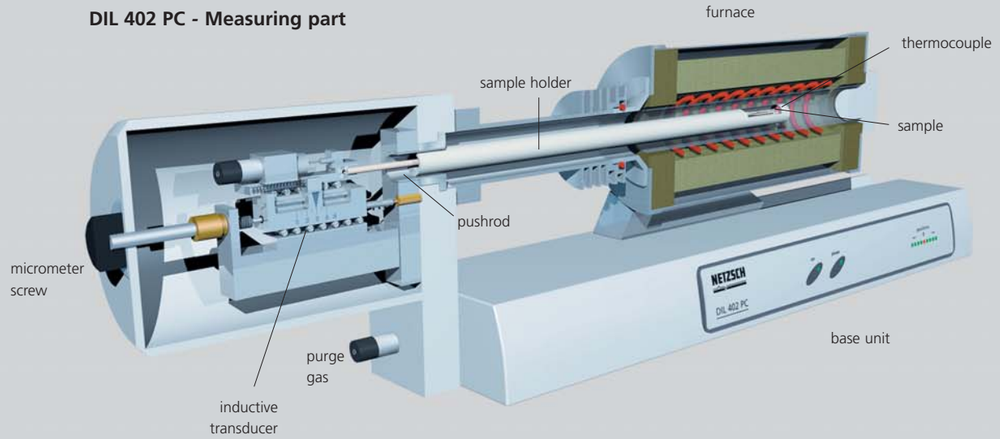
- Thermal expansion
- Coefficient of Thermal Expansion
- Expansivity
- Volumetric expansion
- Density change
- Sintering temperature and shrinkage steps
- Glass transition temperatures
- Softening points
- Phase transitions
- Influence of additives

The newly developed DIL 402 PC is especially tailored to the needs of the glass and ceramic industries. High resolution and stability, wide measurement range, robust and compact design are only some of the advantages of the new, cost-effective system. The system can be equipped with two furnaces, allowing measurements to be carried out from room temperature up to 1200°C or even up to 1600°C.

The system works according to nearly all national or international standards (e.g. DIN 51045 or ASTM E 831).

DIL 402 PC - 1600°C Version

DIL 402 PC - Measuring part



DIL 402 PC - Technical Details

The newly developed DIL 402 PC combines outstanding performance, easy operation, high flexibility and unmatched efficiency in one unit. The improved design of the inductive transducer system compensates for temperature fluctuations and yields highly reproducible data. A chiller is not required.

For example, the forced-air cooling system of the 1600°C-furnace allows cooling from maximum sample temperature to room temperature in less than 90 minutes. Further technical details are listed below.

1200°C-furnace

Technical Specifications

Furnaces (exchangeable):	RT ... 1200°C, RT ... 1600°C
Heating/Cooling rates:	0 ... 50 K/min
Sample holders:	Fused Silica (max. 1100°C), Alumina (max. 1600°C) (user exchangeable)
Sample thermocouple:	type S (Pt/Pt10%Rh)
Measurement range:	500/5000 µm
Resolution:	up to 8 nm/digit
Sample diameter:	≈1 ... 12 mm
Sample length:	0 ... 50 mm
Atmospheres:	oxid. (static, dynamic), inert
Electronics:	integrated TASC 414/5
PC Interface:	USB

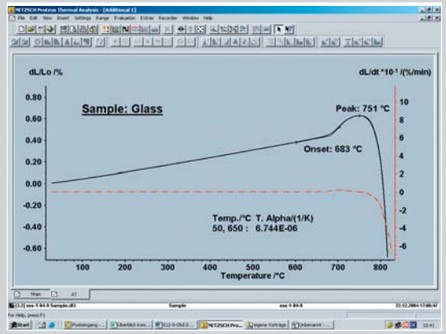
(technical specifications are subjected to change)

DIL 402 PC - Software and Specifications

The DIL 402 PC runs under a 32-bit MS® Windows™ software package including everything you need to carry out a measurement and evaluate the experimental data. Through the combination of easy-to-understand menus and automated routines, a tool has been created that is extremely user-friendly and, at the same time, allows complicated analyses.

Standard Software Features

- MS® Windows™ software: fully compatible with other MS® Windows™ programs
- multitasking: simultaneous measurement and evaluation
- multi-moduling: operation of different instruments with one computer
- combined analysis: comparsion and/or evaluation of DTA/DSC, TG and DIL measurements in one plot
- labeling: input and free placement of text elements
- free scaling of text elements and evaluation results
- calculation of 1st and 2nd derivative
- selectable scaling
- selectable colors and line types
- graphic and data export
- storage and restoration of analysis
- context-sensitive help system
- temperature calibration
- zoom function



DIL Features

- various correction options:
  - sample holder expansion can be corrected with either a calibration measurement or a sample holder correction
  - offset correction
- characteristic temperatures:
  semi-automatic routines for determination of onset, peak and end temperatures
- glass transitions and softening points:
  - evaluations conform to DIN (German standards)
  - automatic softening point detection
- expansion coefficients: graphic or tabular presentation of technical and physical expansion coefficients (coefficients of thermal expansion and expansivity)
- analysis of sintering steps
- automatic determination of the shrinkage during a sintering step

Add-ons

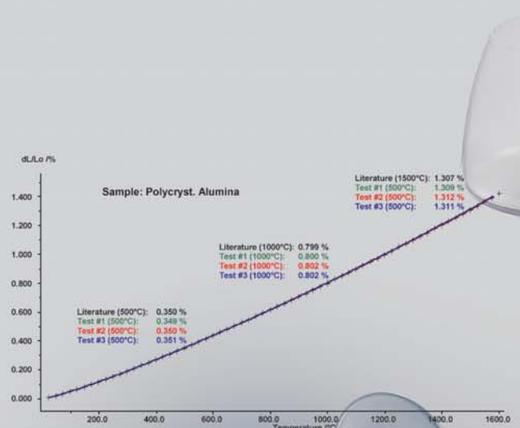
- c-DTA® analysis (option):
  characterization of energetic effects simultaneous to the dilatometer results (calculated DTA)
- thermokinetics: advanced characterization and optimization of sintering reactions
- density software:
  software for determination of volumetric expansion and density changes even in the molten regions.

DIL 402 PC - Performance and Applications

Research & Development - Quality Control - Failure Analysis

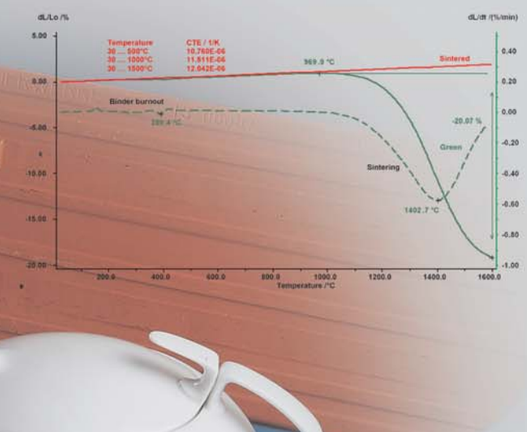
Accuracy: Polycrystalline Alumina

Presented in the figure is a comparison of three test runs (lines) on a polycrystalline alumina (aluminum oxide) with the corresponding literature values (crosses) between room temperature and 1575°C. No visible deviations exist between the individual curves. Evaluation of the thermal expansion values at 500, 1000 and 1500°C clearly shows that the measurement results are within 1% of the corresponding literature values. This tests proves the outstanding reproducibility and accuracy of the new dilatometer.



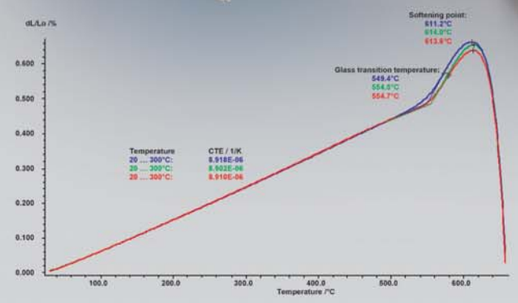
Sintering of Zirconia

During the production of high-tech ceramics, a ceramic powder is mixed with a binder and pressed to a green body. By thermal treatment the binder is removed (burned out) and the ceramic is sintered to the final part. In order to determine the quality of the final part, the binder burnout and sintering temperatures as well as the shrinkage during sintering have to be known. These properties can be measured quickly and easily using pushrod dilatometry. Presented in the figure are tests on an yttria-stabilized zirconia green body and on the sintered ceramic.



Glass

Coefficients of thermal expansion (CTE), glass transition temperatures and softening points are crucial parameters for the characterization of glass materials. Presented in the figure are three tests on same type of glass but from different batches. It can clearly be seen that the coefficients of thermal expansion are in good agreement within the instrument's uncertainty boundaries. The glass transition temperature and the softening point of sample #3 (blue curve) show slightly lower values, indicating a slightly different composition.



Production of Cordierite ceramic

Cordierite is a popular magnesia-alumina-silica ceramic used in various kinds of industrial applications. It is used, for example, as a carrier for catalysts in the automotive industry. During the production of this ceramic, various raw materials are ground and mixed to form a green body. During firing under oxidizing atmospheres, the organic additives are burned out and the cordierite phase is formed at high temperatures. Using the DIL 402 PC in combination with the c-DTA software, the production process can be analysed in detail.