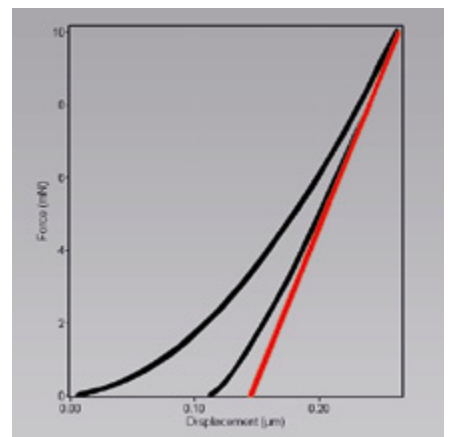
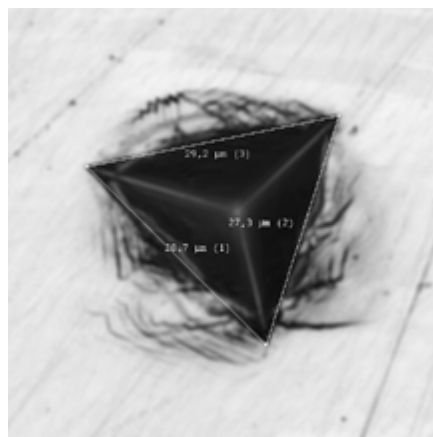
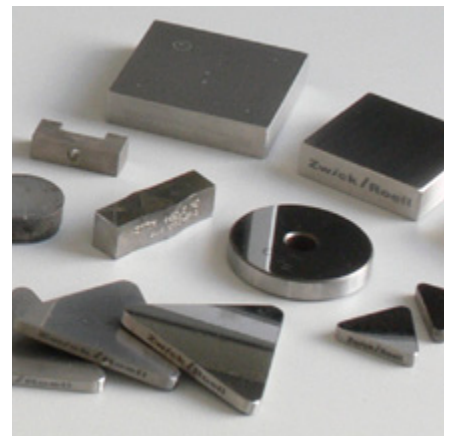


## Hardness Testing with ZwickRoell



Intelligent Testing

## **1 Welcome to ZwickRoell – passionate customer orientation**

For over 160 years the name of ZwickRoell has stood for outstanding technical competence, innovation, quality and reliability in materials and component testing. Our customers' confidence in us is reflected in our position as world-leaders in static testing and the significant growth we are experiencing in fatigue strength testing systems. With innovative product development, a comprehensive range and worldwide service, this family concern supplies tailor-made solutions for the most demanding requirements – in both research and development and quality assurance in over 20 sectors. With more than 1350 employees, a production facility in Ulm, Germany, additional facilities in Europe, USA and Asia plus agencies in 56 countries worldwide, the ZwickRoell brand name guarantees the highest product and service quality.

Customer orientation is the basis of our corporate philosophy. Dependability, straightforwardness and professionalism are the keynotes of our approach. Our aim is to build long-term customer relationships based on mutual trust – we value every customer, from large undertakings to small firms. We always give of our best.

We help our customers to achieve greater success through expert advice, tailor-made solutions, innovative products and comprehensive services.

## **ZwickRoell's comprehensive and innovative hardness testing solutions**

The success of our hardness testing machines and instruments is founded on many years' experience, on our role as a global supplier and on maintaining close contact with our customers. The versatility and high level of 'intelligence' of our testing systems are the product of up-to-date engineering, powerful electronics and application-orientated software.

The ZwickRoell Group has UKAS and DAkkS-accredited ISO 17025 hardness calibration laboratories, traceable to National Metrology Institutes. This guarantees ZwickRoell hardness testers, test blocks and indenters are supplied with traceable certification.



Fig. 1: Innovation center of the ZwickRoell AG and the ZwickRoell GmbH & Co. KG in Ulm, Germany



## Hardness Testing Methods

### Static load application

An indenter with a hard metal ball or a diamond cone/pyramid is pressed into a specimen supported on a firm base. The test load is applied perpendicularly, without shock, and with a defined initial application time and duration.

### Dynamic load application

Large components often require portable devices which normally use dynamic force application.

### Optical indentation measurement

The indentation is measured after removal of the test load. The length measurement values (indentation diagonal, diameter) are used to calculate the hardness value.

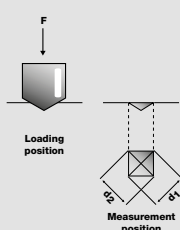
### Depth measurement method

The indentation depth is measured under test load or after removal of additional test load.

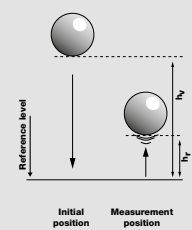
### Energy measurement

Impact velocity and rebound velocity (or height) of impact body are measured.

- Vickers HV
- Brinell HBW
- Knoop HK

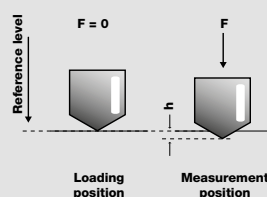


- Leeb HL
- Rebound hardness (e.g. Sclerograph)



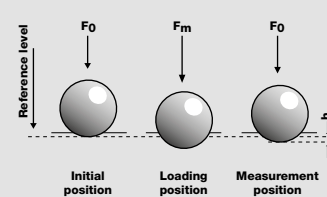
### Measurement under constant test load

- Instrumented indentation test
- Martens HM
- Ball indentation hardness
- Modified method to Vickers HVT



### Measurement under pre-load after removal of the additional load

- Rockwell (A, B, C, D, E, F, G, H, K, N, T, W, X, Y)
- Rockwell (R, L, M, E, K, alpha)
- Modified method to Brinell HBT



## 2 Universal Hardness Testers

### ZHU250CL Universal Hardness Tester

#### Combination of the best

Today's modern all-purpose hardness testing machines are based on technologies making innovative use of mechatronic components. Their high level of precision gives them a wide range of applications, particularly in quality assurance, production-line checks and in the laboratory environment.

In the ZHU250CL hardness tester the latest close loop technology is used for applying test forces. The closed loop control system is designed to have a much lower signal-to-noise ratio than a traditional load cell, thus providing much greater consistency of test force application. The accuracy on all loads beats the requirements according to the relevant ISO and ASTM standards.

The extremely wide test force range of 4.9 N to 2.45 kN (0.5 kg to 250 kg) enables testing according to Vickers, Knoop, Rockwell and Brinell to ISO 6507, ISO 4545, ISO 6508, ISO 6506 and the relevant ASTM standards.

The unique "4-plus-4" turret is able to carry up to 4 lenses and up to 4 indenters simultaneously. The turret is also designed to allow testing in hard to reach positions by using a unique vertical rotation mechanism with an adjustable approach velocity. The dwell time is variable from 5 - 60 seconds. A high-resolution 4 megapixel USB camera is integrated in the hardness tester.

Operation and control of the hardness tester results from the High Definition software (ZHμ.HD). Motorized x-y tables are available for automated hardness traverse tests. With the USB camera and an objective lens a high-resolution overview image of specimen surface can be created via scan function. Automatic indentation measurement - with illumination and shadow correction - removes operator influence in determining hardness values (see further features of High Definition software on page 16).



Fig. 1: ZHU250CL universal hardness tester



Fig. 2: ZHU250CL universal hardness tester in zoom



## ZHU250 Universal Tester

### Robust Know-How

The ZHU250 universal hardness tester is used for the following methods:

- Vickers (HV) ISO 6507, ASTM E 384
- Knoop (HK) ISO 4545, ASTM E 384
- Brinell (HBW) ISO 6506, ASTM E 10
- Rockwell (HR) ISO 6508, ASTM E 18
- Vickers depth measurement HVT VDI/VDE 2616-1
- Brinell depth measurement HBT VDI/VDE 2616-1
- Ball indentation hardness (H) (ISO 2039-1) (plastics)

The ZHU250's robust design guarantees many years of testing in a wide range of applications requiring a test load up to 2.5 kN (250 kgf). It features fast, easy handling.

Optical measuring of indentations uses a digital precision measuring system on a highly tempered, non-reflective focusing screen. A comprehensive range of lenses (magnifications from 15x to 520x) and accessories is available to suit any testing situation.



Fig. 1: ZHU250 universal hardness tester

## ZHU187.5 Universal Tester

### Flexibility for Everyone

The ZHU187.5 is available in versions to suit test loads between 29.4 N and 1839 N (187.5 kgf) for the following methods:

- Vickers hardness (macro)
- Brinell hardness (up to 1839 N)
- Rockwell hardness (classic method)

Features of these instruments include dead weight friction free loading, an automatic test cycle and a nose-mounted indenter providing highly flexible test positions. Load-change is by means of side-mounted rotary knobs; the test method is selected via an LCD line display. The microscope has adjustable graticules to optically measure the indentation. The hardness value appears automatically on the display and can be transmitted to the testXpert III software at the touch of a button. Statistical evaluations and conversions can be performed in addition to entering tolerance limits.

An RS-232 interface plus a wide range of accessories (indenters, support tables, hardness test blocks) are included as standard.



Fig. 2: The ZHU187.5 universal hardness tester

## 3 Vickers Hardness Testers

### ZHV $\mu$ / ZHV30 Vickers Tester

#### Variety to suit

The **ZHV $\mu$  Micro Vickers** hardness tester covers Vickers and Knoop hardness tests to ISO 6507, ISO 4545 and ASTM E 384 within the load range from HV0.01 to HV2.

The hardness tester is equipped with an automatic 6-position turret for up to 2 indenters and up to 4 lenses. This enables Vickers and Knoop hardness tests by menu selection without exchanging the indenter. A wide practical application range is ensured with objective lenses covering total magnifications from 25x to 1000x. The front panel display and integrated microscope allow easy operation and timesaving hardness testing. The test cycle is fully automatic and dwell time can be set in the hardness tester electronics. Load change is also automatic and set in the menu. The intensity of the illumination can be stored for each objective lens individually.

For more sophisticated or automated applications, PC controlled versions are available as semi or fully automatic systems based on the High Definition Software (ZH $\mu$ .HD). The advantage of this software is that it creates an overview image of the specimen in high resolution to define indentation positions. This allows single or multiple traverses to be configured and carried out accurately on the specimen surface. The customer benefits from the linking of the overview picture and the live image. The indentation is shown on the live image with the measurement lens magnification and the software indicates automatically where this position is in the overview image of the specimen surface.

The system is operated and controlled entirely by the software and is particularly used for automated multiple traverse testing.

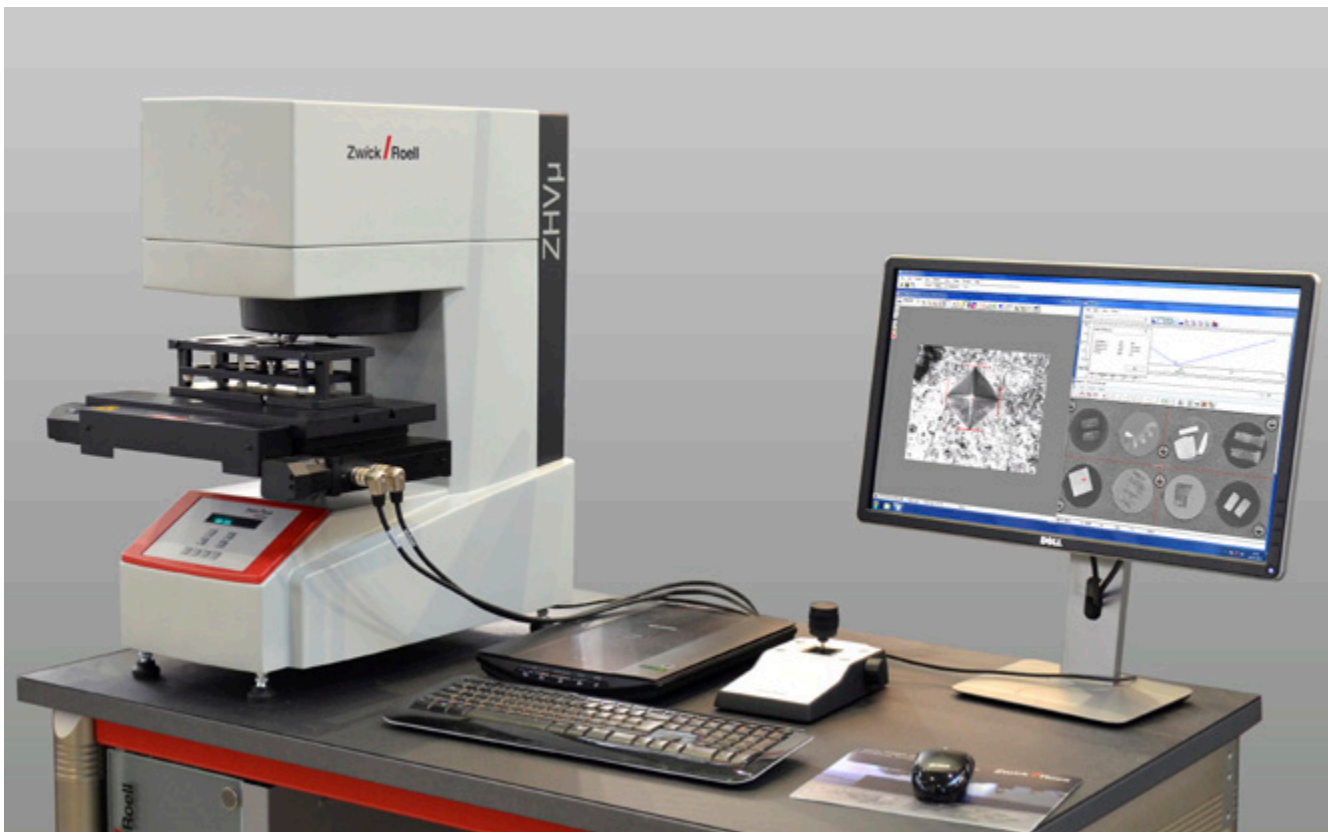


Fig. 1: ZHV $\mu$  Vickers hardness testers with new design and HD software

The **ZHV30 micro/macro Vickers** hardness tester covers Vickers and Knoop hardness tests to ISO 6507, ISO 4545 and ASTM E 384 within the load range from HV0.2 to HV30.

The hardness tester is equipped with an automatic 5-position turret for 1 indenter and up to 4 lenses. A wide practical application range is ensured with different objective lenses covering magnifications from 25x to 500x. The front panel display and integrated microscope allow easy operation and timesaving hardness testing. The test cycle is fully automatic and dwell time can be set in the hardness tester electronics. Load change is also automatic and set in the menu. The intensity of the illumination and individual adjustment is stored for each lens individually.

For more sophisticated or automated applications, PC controlled versions are available as semi or fully automatic systems based on the High Definition Software (ZH $\mu$ .HD). The advantage of this software is that it creates an overview image of the specimen in high

resolution to define indentation positions. This allows single or multiple traverses to be configured and carried out accurately on the specimen surface. The customer benefits from the linking of the overview picture and the live image. The indentation is shown on the live image with the measurement lens magnification and the software indicates automatically where this position is in the overview image of the specimen surface.

The system of this hardness tester is operated and controlled entirely by the software. The system is especially used for automated traverse testing.

ZH $\mu$ .HD software can export hardness test results in three formats: MS Excel for powerful statistical analysis, reporting and 3-D hardness mapping; .csv for importing into 3<sup>rd</sup> party software packages (such as LIMS); testXpert III for user friendly standardised reporting and data storage.



Fig. 1: ZHV30 Vickers hardness tester with manual x-y table



Fig. 2: ZHV30 semi automatic Vickers hardness tester with HD software



Fig. 1: ZHV30/zwickiLine unit for optical hardness test methods



Fig. 2: ZHV30/zwickiLine hardness testing machine

## ZHV30/zwickiLine Vickers Tester

### Precise Control

The ZHV30/zwickiLine hardness tester covers Vickers hardness tests to ISO 6507 and ASTM E 384 and Brinell hardness tests according to ISO 6506 within the load range from 0.98 N to 294 N.

The ZHV30/zwickiLine is a combination of a zwickiLine hardness testing machine, a unit for optical hardness test methods and of the testXpert hardness edition testing software. The system uses a top-loading concept, in which the specimen is mounted on the support and the unit is automatically lowered to the specimen from above, providing maximum flexibility regarding specimen heights. The unit is also equipped with a high-precision load cell, a GigE camera and a 5-position turret for up to 4 lenses and 1 indenter. A wide practical application range is ensured, with different objective lenses covering total magnifications from 50x to 600x.

The turret is available in manual or motorized form for changing from lens to indenter position. Manual or motorized x-y tables plus controllers can be combined as required to provide a tailored testing solution in line with the customer's requirements. The system is operated and controlled entirely by the software.

The system is used in semi or fully automatic mode, also for multiple traverse testing including automatic focusing and automatic indentation size measurement.

A testXpert master test program contains series tests for the Vickers, Knoop and Brinell methods. Optional add-ons are available for automatic indentation measurement, focusing and for traverse testing (including multiple traverses), with manual or motorized x-y tables.

Alternatively, the fully automatic system of this hardness tester can also be used with the testing software High Definition (see page 16).





Fig. 1: ZHV10 analog version



Fig. 2: ZHV10 PC version

## ZHV10 Vickers Tester

### Progress in Tradition

The ZHV10 Vickers hardness tester has a proven track record, especially with:

- Vickers hardness,
- Knoop hardness,
- Brinell hardness,
- Case-depth-hardening, hardening and nitriding depth,
- Scratch hardness (analog unit only).

Loading weights from 0.2 kg to 10 kg (optionally up to 30 kg) and exchangeable lenses for various magnifications and image areas are available for both versions.

Hardness tables are used to evaluate the hardness value when using the **analog unit**.

The **PC version** uses testXpert hardness edition testing software. As well as being simple to operate, testXpert adapts to varying test conditions with great flexibility. This equipment includes a video adapter with a high inherent magnification (approx. 40 fold) which is integrated in the measurement microscope in front of the GigE camera (1.4 megapixel). The LED illumination enables a considerably lower heating up of the measuring microscope and a longer life span.

Various x-y table variants are available:

- with manual micrometer screws or
- with digital micrometer screws for data transfer of the measured coordinates to testXpert hardness edition

Various prisms and clamping devices as well as a parallel vice for fixing the specimens are optional extras.

## 4 Rockwell Hardness Testers

### ZHR Rockwell Tester

#### Unique Accessibility

The ZHR Rockwell hardness testers cover the following methods:

- Classical Rockwell: ZHR 4150 (pre-load: 10 kgf; test load: 60; 100; 150 kgf)
- Superficial Rockwell: ZHR 4045 (pre-load: 3 kgf; test load: 15, 30, 45 kgf)
- Combined Rockwell and Superficial Rockwell: ZHR 8150 (pre-load: 3, 10 kgf; test load: 15, 30, 45, 60, 100, 150 kgf)
- Jominy hardness traverse testing to Rockwell

The machines are available with various levels of operating convenience:

- Models with one-button operation for straightforward testing situations (Type AK, Type BK)
- Models with line-display and integrated conversion functions for standard applications (Type LK)
- Models with touchscreen, expanded functions and high level of operating convenience for wide-ranging test situations (Type SK/TK).

This range of hardness testing machines features modular design, with a wide variety of equipment, allowing the ideal combination to be produced for each application.

A special feature of our Rockwell hardness testers is a nose-mounted indenter for testing difficult-to-access measuring positions. Operation is straightforward, thanks to:

- Automatic test cycle,
- Automatic loading and unloading,
- Automatic evaluation, including conversion,
- Load-weight selection using rotary knob or via touchscreen (automatic load changing).

These testers are of rugged construction, with a play-free ball-bearing spindle, test areas up to 250 mm as standard and optional 375 mm height for large workpieces and an integrated RS-232 interface for connection to testXpert III.

ZwickRoell can also provide a standardized solution for the Jominy end quench test (Rockwell traverse testing, ISO 642 and ASTM A2555).



Fig. 1: ZHR 8150SK and ZHR 4150AK Rockwell tester

## ZHR8150CLK Universal Rockwell Tester

### Specialist for depth measurements

Get reliable test results with the ZHR8150CLK hardness tester, with more than 30 different testing applications using depth measurement methods, e.g. Rockwell & ball indentation tests.

The closed loop force application enables testing according to a wide range of test methods with only one hardness tester, including:

- Metal – ISO 6508 & ASTM E18
- Plastic – ISO 2039-1 & -2, ASTM D785
- Carbonaceous – DIN 51917
- Laminate flooring – ISO 24343-1

The nose mounted indenter allows access to difficult-to-access measuring locations.

Automatic testing cycle, a depth measurement resolution of 10 nm and automatic conversion to alternative scales, saves time and guarantees a high level of test result accuracy and reproducibility.

The robust construction with a pre-tensioned leadscrew and the simple operation is optimal for a shop floor environment.

### And the results?

Experience the intelligent ZwickRoell testing software by exporting your results via USB to testXpert III or into your own data base system.



Fig. 1: ZHR8150CLK during a ball indentation test

## 5 Instrumented Indentation Hardness Testers

### ZHU/zwickiLine+ Universal Tester

#### Innovation & Competence

The ZHU/zwickiLine universal hardness testing machines can be used for all the classical testing methods, including Rockwell, Vickers, Brinell and ball indentation hardness. They are also well-suited to the innovative instrumented indentation test. This is used to determine hardness plus additional mechanical materials parameters and is known as Martens hardness (ISO 14577). Furthermore cyclic indentation tests with increasing test force or indentation depth and partial load removal are realized in the testing software testXpert hardness edition.

The ZHU/zwickiLine+ features a hardness measuring head (resolution 0.002  $\mu\text{m}$ ) with integrated digital depth and depth force measuring system, mounted in a zwickiLine+ testing machine. Combine our state-of-the-art measuring and control electronics testControl II and our intelligent testing software testXpert hardness edition and the result is a well-balanced, high-precision measuring system.

Also available is an add-on optical unit which, when used with the hardness measuring head, allows any current hardness method to be tested. The optical unit consists of a measuring microscope with various lenses and a linear displacement unit. The linear displacement unit allows a change from the hardness measuring head with indenter to the optical unit position without the specimen being moved.

#### Indentation depth methods:



Fig. 1: ZHU2.5/Z2.5 universal hardness testing machine with motorized hardness measuring head

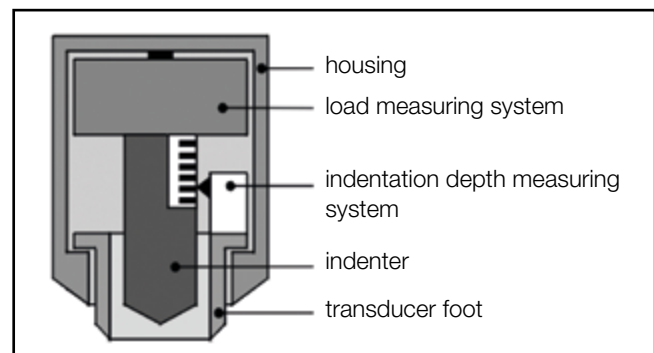


Fig. 2: General layout of the hardness measuring head

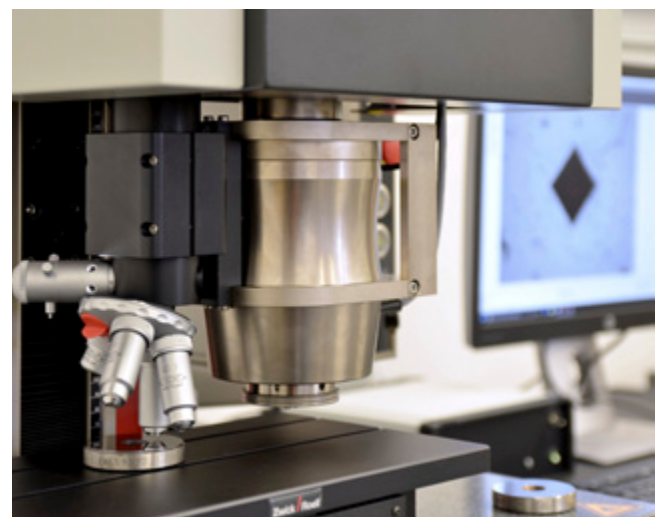


Fig. 3: ZHU/zwickiLine+ with testXpert hardness edition



- Instrumented indentation test (Martens hardness, ISO 14577)
- Rockwell hardness HR - ISO 6508
- Rockwell hardness HR - ISO 2039-2
- Vickers depth measurement HVT
- Brinell depth measurement HBT
- Ball indentation hardness H (for plastics) - ISO 2039-1

### Indentation area methods:

- Vickers hardness HV - ISO 6507
- Brinell hardness HBW - ISO 6506

The ZHU/zwickiLine+ range is complemented by a comprehensive, standardized range of accessories. This includes a highly varied selection of indenters, hardness test blocks and clamping systems.

### More than just hardness

- Universal, material-independent application for practically all hardness testing methods with indentation depth measurement
- High accuracy and repeatability of test data through high-resolution measurements and constant test conditions
- Automatic display of force-indentation-depth curve regardless of method, for comprehensive materials characterization in instrumented indentation test to ISO 14577
- High operating comfort with changing test conditions due to fast and precise AC drive and large test area, e.g. for different specimen sizes
- Multiple use as a hardness testing machine and/or as a testing machine for tensile, compression & bending tests
- Versatile result presentation: single and statistical values, graphics, on-screen display, and test reports can be varied as required

## Options



### testXpert testing software

The intelligent testing software testXpert supports the innovative testing system in standard testing situations (e.g. quality assurance) as well as in research and development for very sophisticated tasks.



### LED illumination

The frontlight coaxial lamp has LEDs for longer life and greatly reduced heating of the measuring microscope.



### Hardness measuring heads

To facilitate high-precision measurements in various application areas, two hardness measuring heads are available:  
2 N ... 200 N or 5 N ... 2.5 kN



### X-y tables

Manual or motorized x-y tables with travel up to 150 mm are available.



### Optical unit

The optical unit consists of a measuring microscope with various lenses and a displacement unit for easy changes between indenter and optics positions.



### Accessory for materials testing

Combine the hardness testing machine with tools or grips for compression, bending or tensile tests.



Fig. 1: ZHN universal nanomechanical tester fully equipped with normal force unit (NFU) and lateral force unit (LFU)



Fig. 2: ZHN with housing for thermic and accoustic isolation

## ZHN Nanomechanical Tester

### A new Dimension

The Universal Nanomechanical Tester ZHN's unique force and displacement resolution enables comprehensive mechanical characterization of thin films and coatings or small surface areas, including measurement of indentation hardness, indentation modulus and Martens hardness to ISO 14577.

Two patents cover ZHN's measuring heads:

- the Normal Force Unit (NFU)
- the Lateral Force Unit (LFU)

Working with one measuring head (**Normal Force Unit**), ZHN functions as a depth-sensing hardness tester in the micro range, with a maximum force of 20 N. It can also be used in the nano range for indentation depths less than 200 nm.

A 2 N head and a 0.2 N head with accordingly higher force resolution are optionally available.

A unique feature of the ZHN is the second independent measuring head with the same excellent resolution for the lateral direction, the **Lateral Force Unit**. The two measuring heads can be combined in any way required - for a greatly increased range of measuring options.

The instrument can considerably additionally be used as:

- a micro scratch tester
- a micro wear tester
- a fatigue tester and
- a high-resolution profilometer.

## Options



### Indenters

All types of indenters can be delivered, e.g. Vickers, Berkovich, Cube Corner, Knoop, spheres, flat punch or wedge.



### Sample holders

There are different types of sample holders available: 1x for Ø 50 mm and 5x for Ø 24 mm, and even various holders for foils, thin sheets or wires.



### Lateral Force Unit

Second independent measuring head with the same excellent resolution for the lateral direction for the measurement of wear, fatigue and as a micro scratch tester.



### Optic variants

Additional to the installed 50x objective lens a 5x lens it is possible to install a 5x lens, an AFM (Atomic Force Microscope) or a White light interferometer.



### Vibration isolation systems

For the optimal use of the tester an active vibration isolation system and a low vibration base frame are recommended.



### Optional software

The QCSM method allows measuring the contact stiffness of the sample with the help of an unload curve for many points during the indentation procedure.

## Other unique features:

- Both measuring heads can work in compression and tensile mode.
- Dynamic measuring modes are available for both heads. Small oscillations with a frequency of up to 300 Hz are added to the force or displacement signal, allowing virtually continuous analysis of contact stiffness.
- Extremely robust construction eliminates any risk of sensor damage and allows easy handling.
- The standard diamond indenter can easily be replaced by other indenters of any shape and material without a substantial loss of accuracy, particularly useful for special wear or adhesion tests.

The instrument is combined with x-y-z tables with travel ranges of 100 mm (x), 200 mm (y) and 70 mm (z) with a resolution of 50 nm. It also includes high-resolution optics, with two cameras and an auto-focus system. Many elements of the instrument can be adapted to suit customers' requirements.

## Additional features:

- User-friendly software operation with the software InspectorX, especially designed for the analysis of instrumented indentation tests
- Fully automatic approach, even with varying specimen heights
- Fully automatic measurements, including image generation of the measurement positions; any measurement sequences programmable
- Virtually unlimited number of measurement positions can be preset
- Shortest possible testing times
- Multiple curve overlay for direct comparison of all curves in a series
- Configuration of user-specific test sequences (applications)

## 6 Testing Software

### High Definition Testing Software

#### User-friendly Precision



When a hardness testing solution which delivers reliable, accurate and repeatable test results is needed, choose from the ZH $\mu$ .HD line of macro and micro hardness testing solutions - field-proven systems, offering beyond comparison capabilities and fully ASTM E 384, ISO 6507 and ISO 4545-compliant.

#### Precise positioning

With its image of the entire specimen by 2.5x lens or via scan function and its annotation tools, ZH $\mu$ .HD Software enables you to position indents precisely where they are required.

#### Precise, repeatable measurements

The high image resolution of the ZH $\mu$ .HD Software allows measurement of indents to be precise and repeatable.

#### Enhanced productivity

The ZH $\mu$ .HD Software combines ease of use, reliability and auto-calibration, minimizing the subjectively associated with human intervention. The system can run autonomous for hours without interruption.

#### Sophisticated reporting

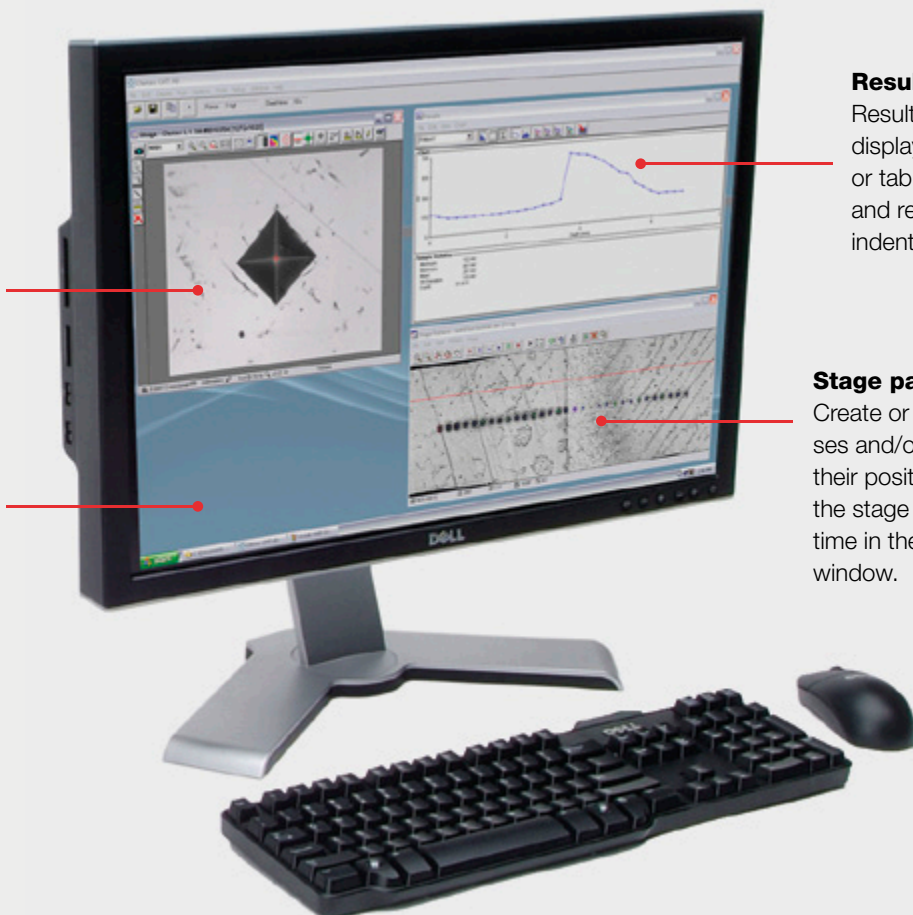
The results are automatically transferred via data interface from ZH $\mu$ .HD software to testXpert III - the testing software for all Zwick testing machines and instruments. According to your requirements the reports are now generated.

#### Image window

The intuitive image window interface allows easy viewing of specimen surface and indents.

#### Individual Workspace

Maximize your workspace by running in a high-resolution environment of 1920 x 1200 pixels or more.



#### Results window

Results are clearly displayed in graphical or tabular form. Track and review individual indentations.

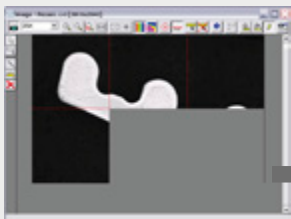
#### Stage pattern window

Create or modify traverses and/or patterns and their positions, then see the stage move in real time in the stage pattern window.

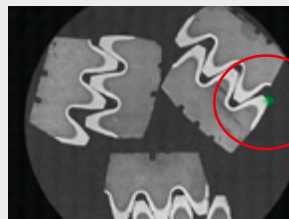


## Step 1: Set the entire specimen <sup>(1)</sup>

Place the specimen in the specimen holder and - with one click - build a high resolution overview image of the specimen and set reference points for more traverses using annotated tools.



Building mosaic image to a complete image



Precise positioning at any magnification

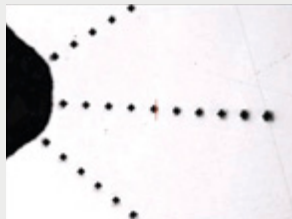


## Step 2: Set-up traverses/patterns

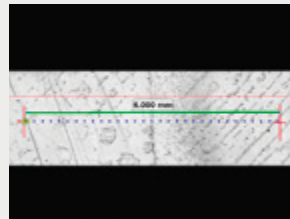
Open, modify, or create new traverses/patterns using reference points or lines. Traverses and patterns can be individually adjusted.



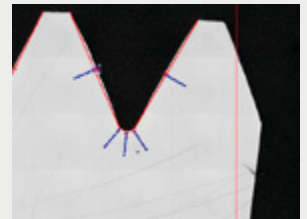
T-Bar rotation tool



Three traverses perpendicular to edge



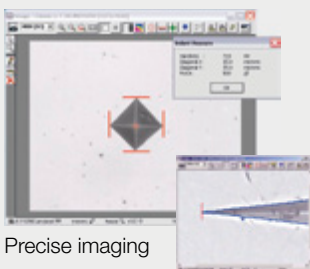
Traverse centred in weld sample



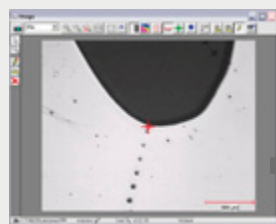
Five traverses perpendicular to the edge of the gear

## Step 3: Click & walk away

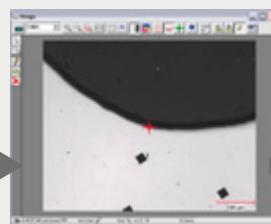
ZHμ.HD Software intelligently follows the predefined patterns, indents the specimen, focuses if needed, measures and generates data dynamically. Everything is automated, freeing users for other tasks.



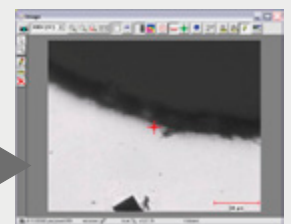
Precise imaging



with 2.5 x objective lens



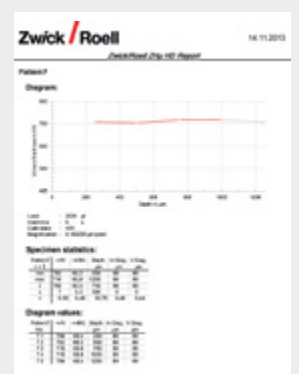
with 10 x objective lens



with 40 x objective lens

## Step 4: Get results

Review results in graphical and/or tabular format. Export results to the spreadsheet application of your choice, or to **testXpert III** for creating and printing standard or customized reports.



<sup>(1)</sup> Function not available in the US

## testXpert hardness edition

### Intelligent & Reliable



### One basic software for all applications

testXpert employs the same basic software system for all hardness applications. It is responsible for data, user and test program management, as well as communication between the hardness testing machine or hardness testing device and other peripheral systems.

### Master test programs

Master test programs cover the test categories which are designed for frequently changing or complex test requirements. With a minimum of effort and previous knowledge it is possible to

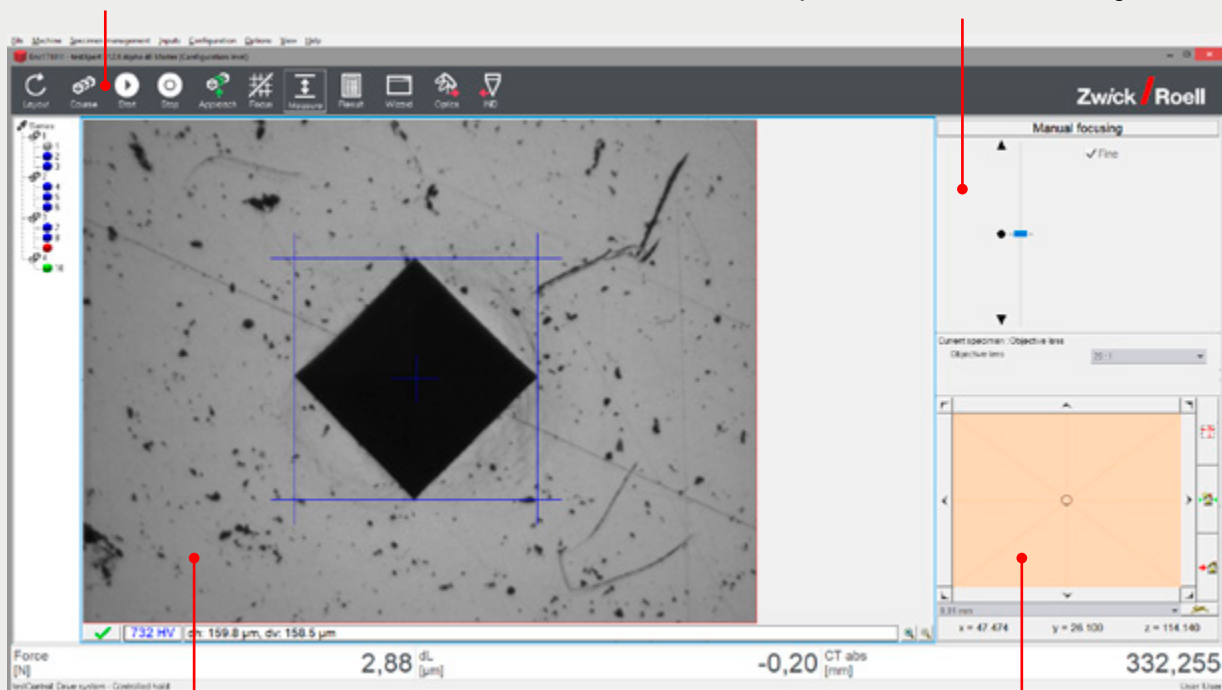
- create and alter test programs,
- configure screen views according to individual needs and
- create task specific test reports.

The intelligent software wizard guides you rapidly through all menus, running consistency checks at the same time.

Two master programs are available for hardness testing machines and devices:

- Optical hardness testing methods (Vickers, Knoop, Brinell)
- Instrumented indentation test and hardness testing method with indentation depth measurement

The **menu bar** appears at the top of the user interface in all layout windows, with the toolbar underneath and the serial tree on the left.



### Virtual z axis control

The motorized z axis of the hardness tester is moved via the software by means of a virtual slider, using the mouse.

### Video image showing measured values

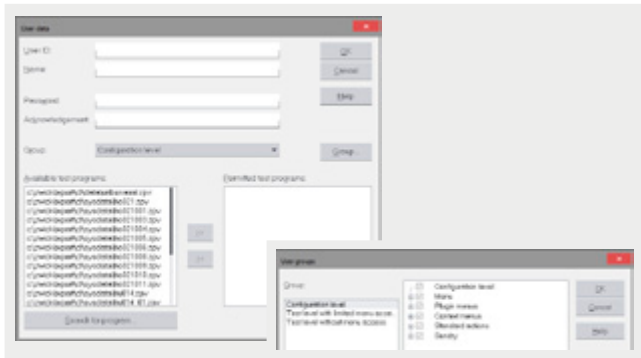
The status bar of the video image screen incorporates a button for confirming the measured lines. The hardness value and the gage lengths are displayed automatically and accepted as results by pressing the button.

### Virtual x-y axis control

The motorized x-y table is moved in steps by means of the „arrow“ buttons or continuously by displacing the circle (while holding the mouse key). The degree of displacement determines the traversing speed.

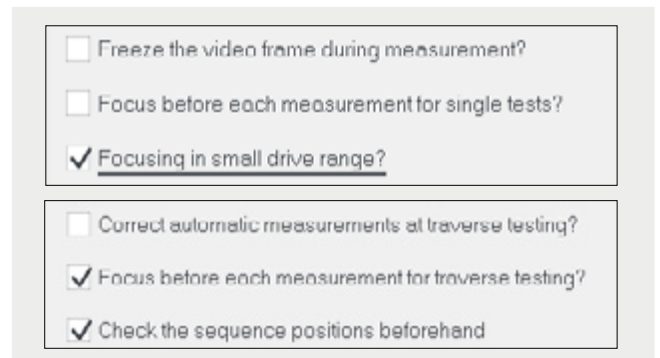
## User management

testXpert includes a user management system with different access options available to defined user groups. New groups are simple to define and configure.



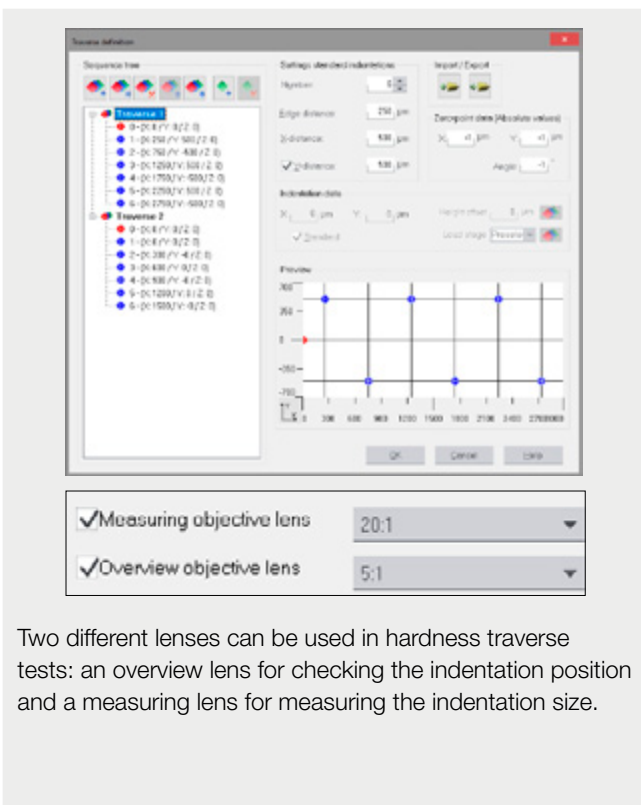
## Configuration of a test sequence

The test sequence is simple to adjust with regard to checking of the indentation position, autofocussing prior to indentation measurement and automatic indentation measurement.



## Definition of traverses

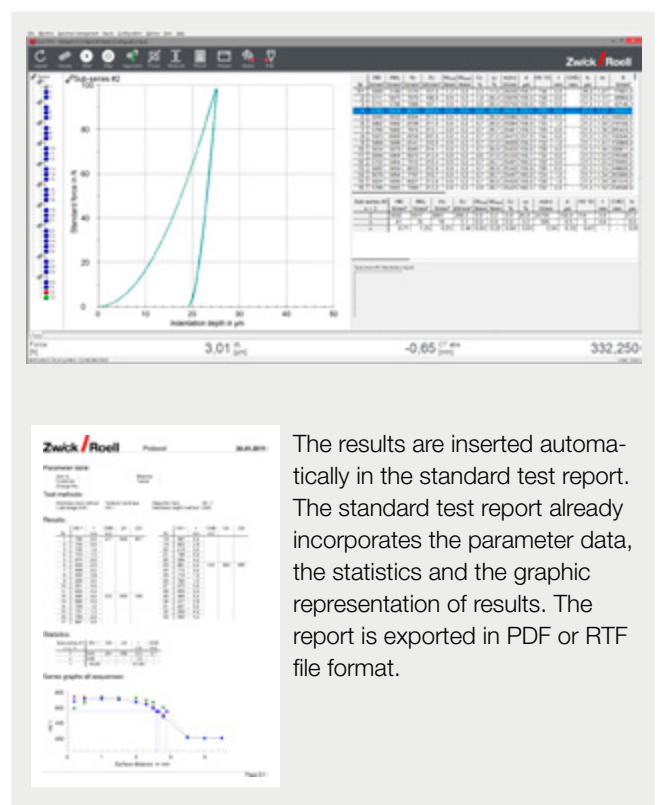
Simple configuration, copying, shifting and modification of hardness traverse tests take place in the „Traverse test definition“ mask. Existing samples can be stored and exported or imported and modified.



Two different lenses can be used in hardness traverse tests: an overview lens for checking the indentation position and a measuring lens for measuring the indentation size.

## Presentation of test results and test reports

In testXpert the test results are displayed automatically in graphic and tabular form and are statistically evaluated. The user interface and the standard report are simple to adapt to the user's requirements.



The results are inserted automatically in the standard test report. The standard test report already incorporates the parameter data, the statistics and the graphic representation of results. The report is exported in PDF or RTF file format.

## InspectorX Testing Software

### Thin layers perfectly analyzed

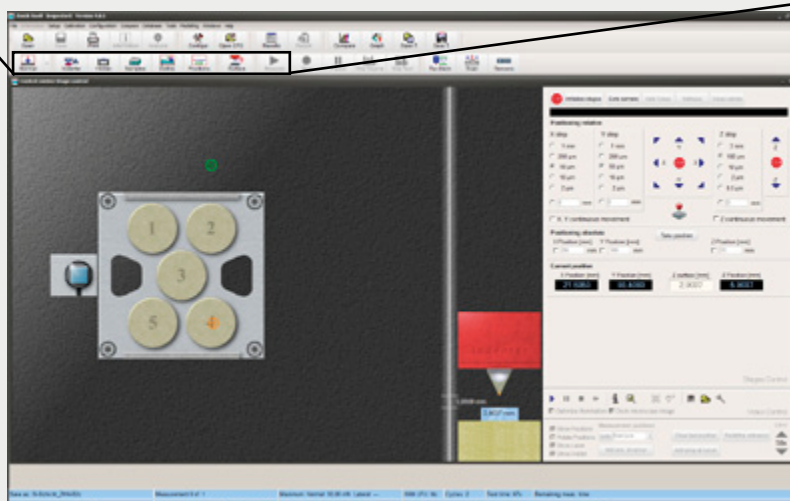


InspectorX is the intuitive control and analysis software of load-displacement data for the determination of mechanical parameters with the ZHN Nanoindenter. For small depths of indentation it is very important to gain a high accuracy of the correction functions for the tip shape as well as for the zero point (position of the surface) and thermal drift.

InspectorX offers especially sophisticated correction routines and algorithms, whose quality was proven, for instance, by comparative measurements of the Physikalisch-Technische Bundesanstalt (PTB):

- Determination, description and correction of instrument compliance or stiffness
- Determination and description of indenter area function (24 different fit functions available)
- Zero point correction (automatic or manual)
- Thermal drift correction (automatic or manual)
- Creep analysis (fit of the creep curve, calculation of creep rate)
- Analysis of dynamic data (continuous or quasi continuous stiffness measurement)
- Special analysis of wholly elastic measurements using a Hertzian contact model for coated materials with up to three layers
- Determination of stress-strain curves of metals from indentations with spherical indenters

- |  |  |   |  |   |  |                                      |
|--|--|---|--|---|--|--------------------------------------|
| <b>Step 1:</b><br><b>Choose force unit (NFU / LFU)</b> | <b>Step 2:</b><br><b>Select the indenter</b> | <b>Step 3:</b><br><b>Choose sample holder (e.g. 5x)</b> | <b>Step 4:</b><br><b>Select sample / enter the sample data</b> | <b>Step 5:</b><br><b>Define test method (e.g. QCSM)</b> | <b>Step 6:</b><br><b>Set positions (acc. to test method)</b> | <b>Step 7:</b><br><b>...Measure!</b> |
|--|--|---|--|---|--|--------------------------------------|



Main window after initialization of the x-y stages



## Control of the precision stages

The device is designed for fully automatic measurement series with more than 1000 possible measuring positions. The control software InspectorX gives a complete overview of the actual positions of the three precision stages and allows easy control with step sizes below 1  $\mu\text{m}$ . When the sample is positioned under the microscope, an image of the sample surface is shown in the same window instead of the stage positions.

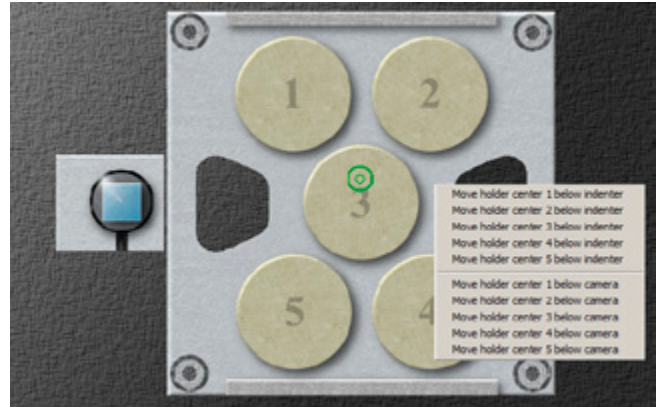


Fig. 1: Control of the precision stages

## Definition of the measuring positions

Any number of positions can be programmed optionally in lines, columns, grids or in irregular arrangement. Unique features are the possibility to define different measuring procedures for every position and to automatically generate pictures with two different magnifications before and after the measurement using the autofocus function. Comprehensive sample information can be assigned to every position and will be stored in data files.

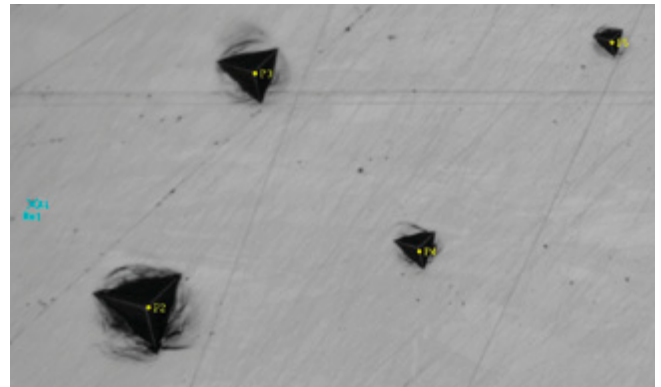


Fig. 2: Indentations with a Berkovich indenter

## Definition of the measuring procedure

A large number of predefined applications that may be selected by a simple mouse click is available. Procedures (test cycles) with any number of load-unload segments can be programmed and modified in a very flexible manner. Force or displacement, measuring time and data rate of a segment can be defined in "open loop mode" while in "closed loop mode" the number of data points and the dwell time per point may be set in addition.

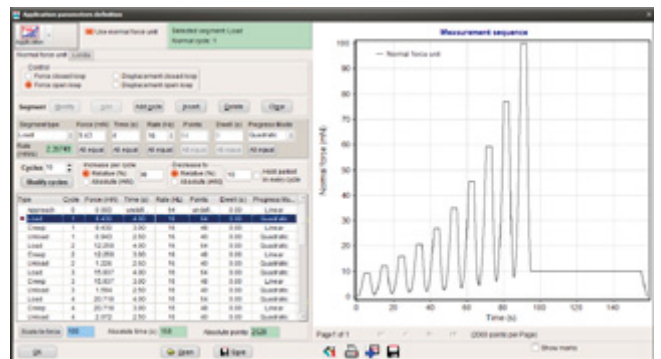
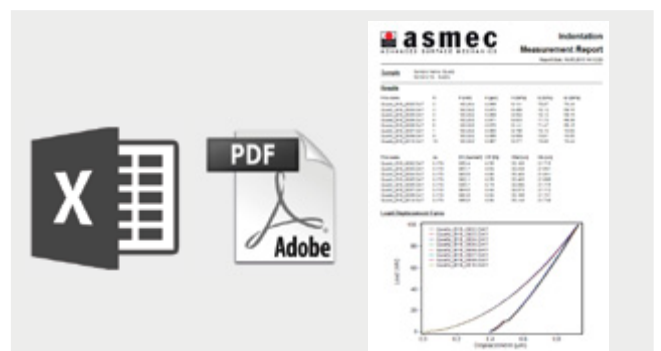







Fig. 3: Application window

## Evaluation of measurement data

Load-displacement curves or other data can be graphically presented, compared, averaged or exported in different formats. Comprehensive and flexible correction routines are available for data evaluation. Parameters for the analysis and the presentation of results can be stored in configuration files and exchanged among others.



## 7 Portfolio Overview

					
	<b>ZHU250CL</b>	<b>ZHU250</b>	<b>ZHU187.5</b>	<b>ZHV<math>\mu</math></b>	<b>ZHV30</b>
Test loads (all models)	4.9...2454 N	4.9...2454 N	29.4...1839 N	0.1...19.6 N	1.96...294 N
Application	Metals Plastics Ceramics	Metals Plastics Ceramics	Metals Plastics <sup>1)</sup> Ceramics <sup>1)</sup>	Metals Ceramics <sup>1)</sup>	Metals Plastics Ceramics
Rockwell	✓	✓	✓	-	-
Superficial Rockwell	✓	✓	-	-	-
Rockwell (L, M, R)	✓	✓	✓	-	-
Ball indentation	✓	✓	-	-	-
HVT, HBT	✓	✓	-	-	-
Instr. indentation	-	-	-	-	-
Martens	-	-	-	-	-
Vickers	✓	✓	✓	✓	✓
Knoop	✓ <sup>1)</sup>	✓ <sup>1)</sup>	-	✓	✓
Brinell	✓	✓	✓	-	✓ <sup>1)</sup>
Software	HD (+ tXpIII)	testXpert III	testXpert III	HD (+ tXpIII)	HD (+ tXpIII)
Test area, max. (H x D in mm)	375 x 150	300 x 250	250 x 150	150 x 150	250 x 150
Versions	ZHU250CL-s ZHU250CL-a	-	ZHU187.5 ZHU150	ZHV $\mu$ -m ZHV $\mu$ -s ZHV $\mu$ -a	ZHV30-m ZHV30-s ZHV30-a

<sup>1)</sup> suitable, however limited load range/material-dependent

					
ZHV30/zwicki	ZHV10	ZHR	ZHR8150CLK	ZHU/zwicki+	ZHN
0.98...294 N	1.96...98 N	147...1471 N	4.9...1471 N	1.96...2452 N	0...20 N
Metals	Metals Ceramics	Metals Plastics	Metals Plastics Carbonate	Metals Plastics <sup>1)</sup> Ceramics, Paper	Metals Plastics Ceramics
-	-	✓	✓	✓	-
-	-	✓	✓	✓	-
-	-	✓	✓	✓	-
-	-	-	✓	✓	-
-	-	-	-	✓	-
-	-	-	-	✓	✓
✓	✓	-	-	✓	✓ <sup>1)</sup>
-	✓	-	-	-	✓ <sup>1)</sup>
✓ <sup>1)</sup>	✓ <sup>1)</sup>	-	-	✓	-
testXpert HD (+ tXpIII)	testXpert	testXpert III	testXpert III	testXpert InspectorX	InspectorX
670 x 99.5	300 x 135	250 x 150	250 x 150	675 x 105	70 x 200
turret manual/ motorized	ZHV10 analog ZHV10 PC	AK/BK/LK/SK/TK 4045/4150/8150	ZHF8150CLK	ZHU0.2 ZHU2.5 manual/motorized linear displacement unit	0...20 N 0...2 N 0...0.2 N LFU

<sup>1)</sup> suitable, however limited load range/material-dependent

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