

# GEMMOLOGICAL STEREO-MICROSCOPES AND MOBILE GEMSTONE LABORATORIES



Mineral	Zoisite
Variety	Tanzanite
Light refraction (n)	1.691-1.705
Birefringence ( $\Delta n$ )	0.008
Optical character	biaxially positive
Pleochroism	very strong: red-violet, blue and green-yellow
Density g/cm <sup>3</sup>	3.23 3.38
Fluorescence	none
Crystal system	orthorhombic
Origin	Merelani Hills, Tanzania
Colouring	Vanadium

©Tanzanite with graphite on calcite Collection: Marcus Budil, Photo: Malte Sickinger



Special gemstone microscopes are used for the determination and quality control of gemstones. They are used to observe internal properties and check external characteristics such as damages and quality of the cut. In the science of gemmology, all visually recognisable irregularities within gemstones, such as material foreign bodies (minerals, liquids, gases), cracks, colour zoning or twin lamellae, are understood as inclusions. They are often not visible to the naked eye, unless a microscope is used. The type and form of the inclusions are often a good indication of which gemstones are involved and from which sources they originate. The origin and genesis of gemstones can manifest themselves in characteristic inclusions.

In addition to the usual microscope components, gemstone

microscopes have stone and cuvette holders and polarisation filters. The instruments can be used horizontally as well as vertically (KSW 5000-T-K-W / KSW4000-K-W), depending on the configuration. Many of our microscopes provide variable illuminating devices: These types of special illumination equipment enable bright-field and dark-field illumination and microscopy with incident light equipment.

Microscopes are further differentiated according to the number of eyepieces and objectives. There are monocular microscopes (1 eyepiece/ 1 objective), binocular microscopes (2 eyepieces/ 1 objective) and stereo microscopes (2 eyepieces/ 2 objectives). A.KRÜSS microscopes for gemmological use are usually stereo microscopes.

### FUNCTIONALITY

A stereo microscope is sometimes mistaken for a simple binocular microscope.

The binocular microscope produces an image with only one objective and makes it visible to both eyes.

The stereo microscope, on the other hand, is a special light microscope in which a separate beam path is provided for both eyes (Figure 34b).

Both eyes therefore see the stone under examination from a slightly different angle, so that a stereo effect occurs. The human brain combines the two images into a single image with some depth. This creates an almost spatial impression, which is the reason for the name stereo (two-channel) microscope. This almost three-dimensional impression when viewing facilitates many examinations in gemmology.

All A.KRÜSS microscopes are stereo microscopes.



Fig.34a: Gemstone interior seen through the stereo microscope. Photo source: © Friedrich Reinhardt Verlag/Basel - Photoatlas of Inclusions in Gemstones

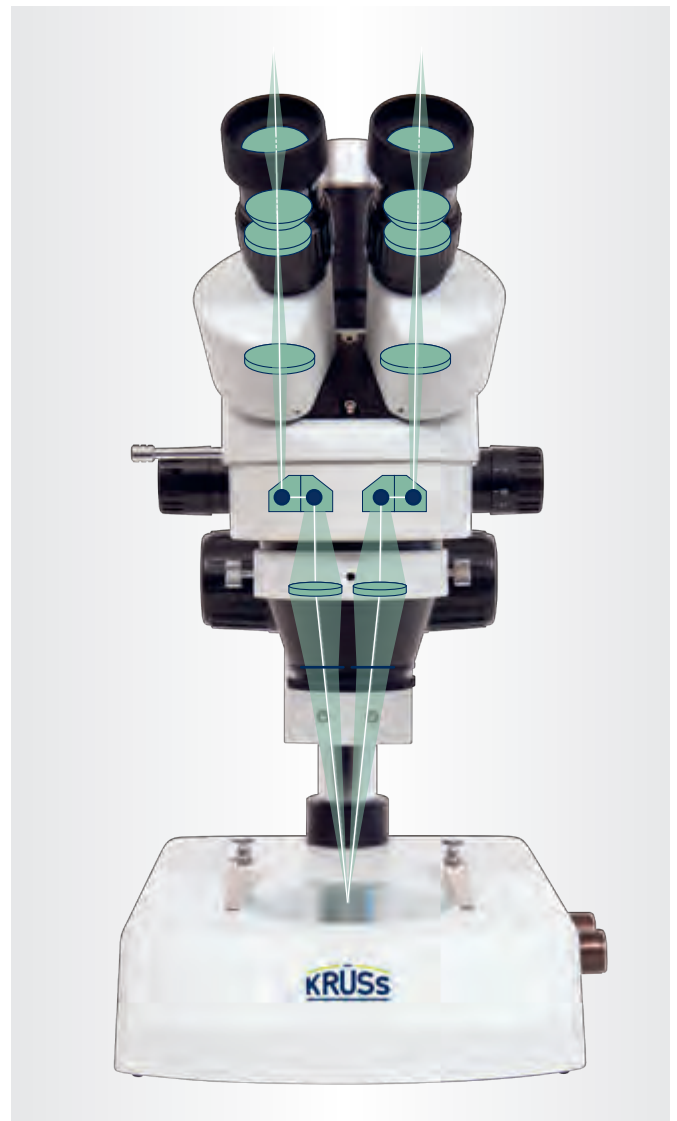


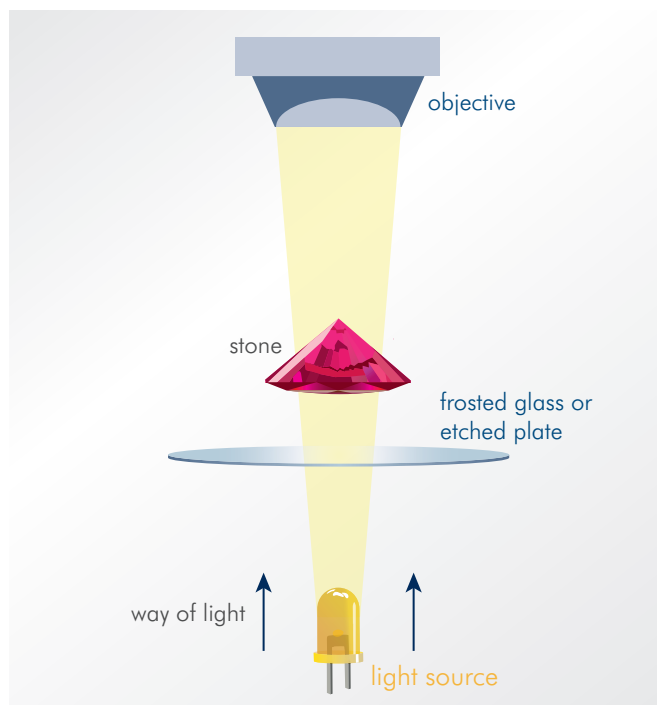
Fig.34b: Schematic illustration of the beam path using a gemmological stereo microscope.



## TYPES OF ILLUMINATION AND THEIR APPLICATION

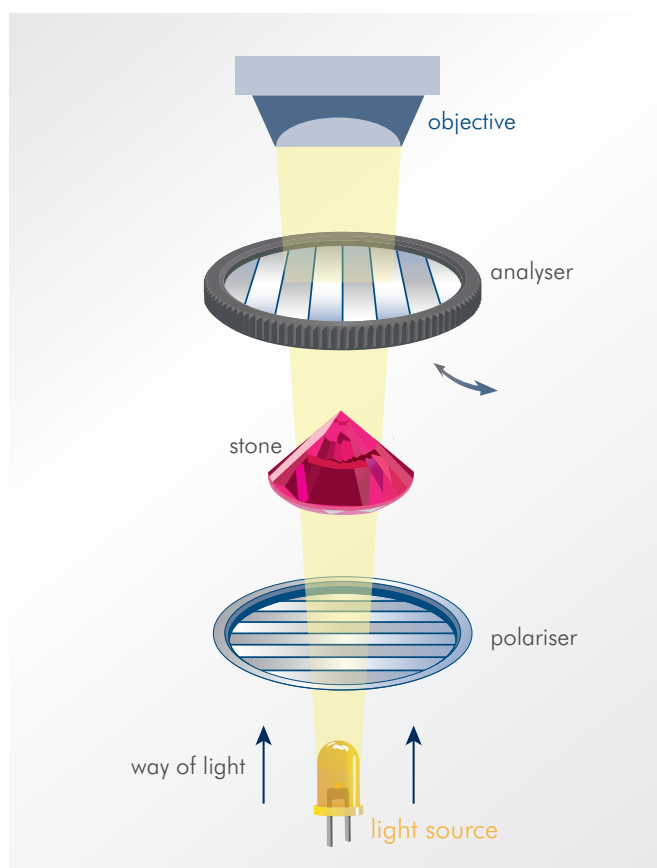
### FUNCTIONALITY BRIGHT-FIELD MICROSCOPY

**Bright-field microscopy** is the most important method adopted for the investigation of gemstones. In this way most of the inner characteristics of a gemstone can be detected. In bright-field microscopy, the stone is illuminated from below and can thus be studied microscopically by means of the transmitted light. Examples are shown in Figures 41, 42 and 43. With the aid of a stone holder, the stone is held above the light source and rotated into the desired position.



Figs. 35a (left) and 35b: Bright-field microscopy of a gemstone and schematic depiction of this illumination.

In addition, certain A.KRÜSS microscopes incorporate two polarisers, components which provide invaluable aid when a gemstone is being examined. When the bright-field or transmitted light mode is used to analyse the light passing through the stone with the help of parallel or crossed polarisers, then it's possible to observe such features as pleochroism, anisotropy or internal stress. The polarisation device comprises a firmly integrated polarisation filter (polariser) below the object to be examined, together with an insertable and movable polarisation filter (analyser) above the object (Fig. 36b).

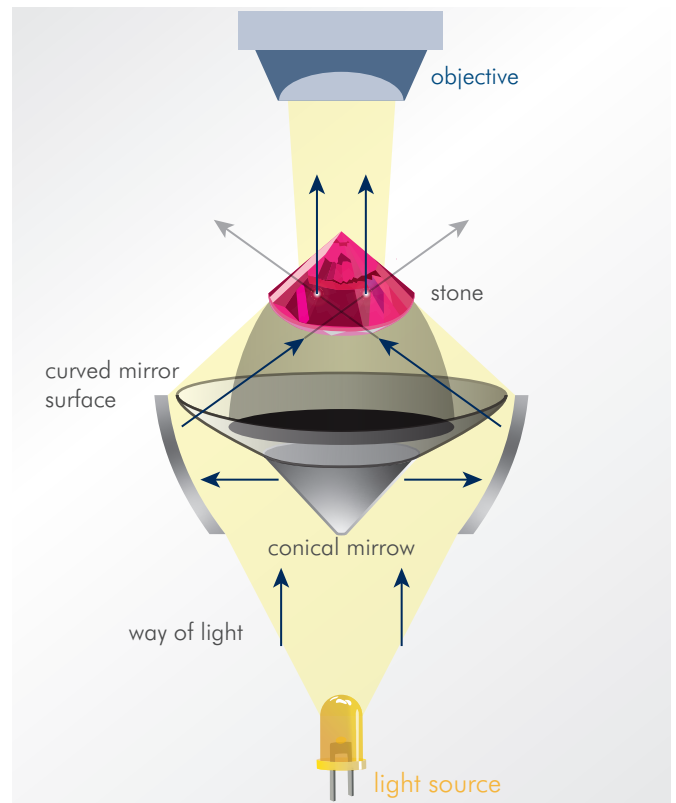


Figs. 36a (left) and 36b: Bright-field microscopy with polarisation units and schematic depiction of this illumination.

## MICROSCOPY

### FUNCTIONALITY DARK-FIELD-MICROSCOPY

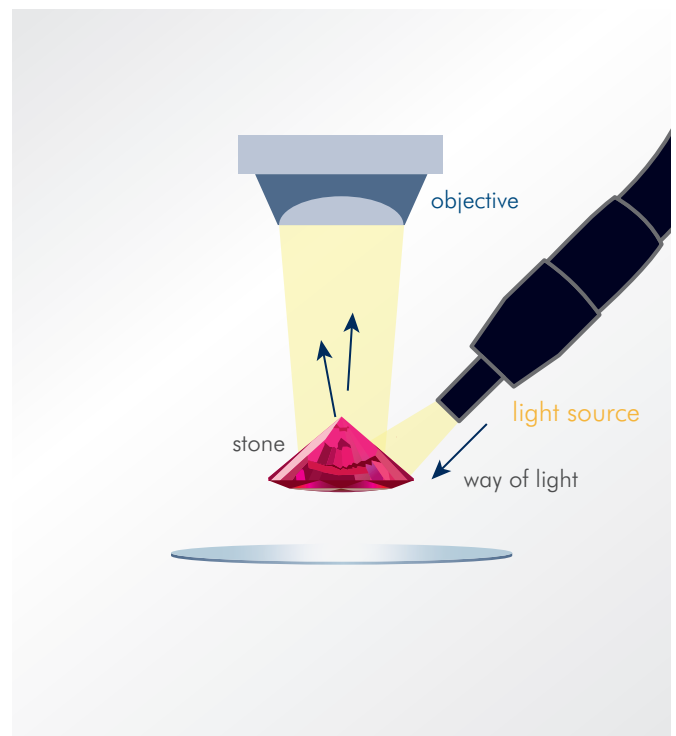
**Dark-field microscopy** is ideally suited for especially close examination of transparent or low-contrast inclusions. In this case the directly transmitted light is blocked and the stone only illuminated from the side (Figure 37b). This side light is reflected and scattered at the inclusions, thus making them particularly visible. As a result, a bright image is created against a dark background. Examples of this investigation method are shown in Figures 40 and 44.



Figs.37a (left) and 37b: Dark-field microscopy of a gemstone and schematic depiction of this illumination.

### FUNCTIONALITY MICROSCOPY WITH AN INCIDENT-LIGHT DEVICE

When microscopic examination is conducted with the aid of an incident-light device, light is not directed towards the stone from below, but from above or from the side (oblique illumination). This can also be effected in combination with bright-field or dark-field microscopy, as can be seen, for example, in Figure 40. Illumination can be generated by means of an independent illuminating device attached to the microscope, i.e. an LED ring light below the objective, or, alternatively, via a cold-light source with a gooseneck light guide.

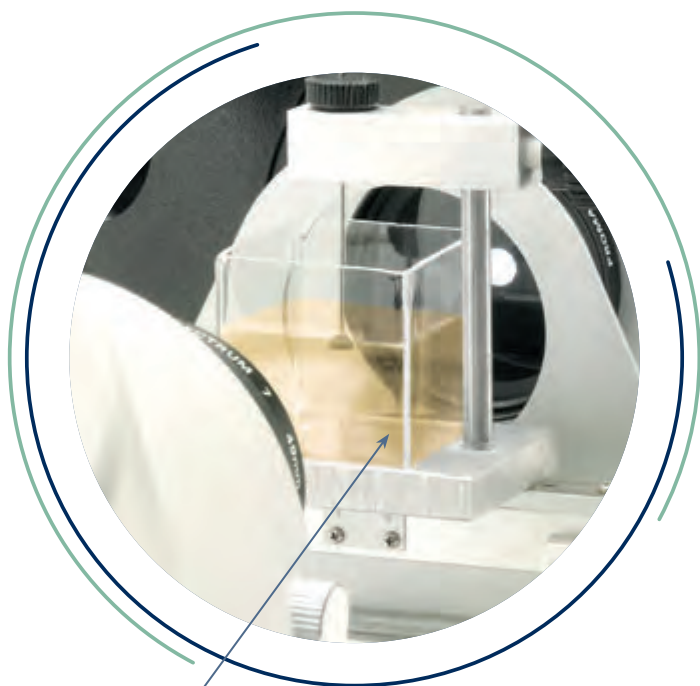


Figs.38a (left) and 38b: Using an incident-light device on the basis of dark-field microscopy and schematic depiction of this illumination

## INVESTIGATION WITH IMMERSION LIQUID

Gemstones are embedded in different immersion liquids to make them easier to examine under a microscope. These should have a similar refractive index as the stones to be examined. To examine with immersion liquid, the liquid is filled into a glass cuvette and the stone to be examined is positioned in the liquid by means of the stone holder. The stone holder is designed in such a way that the stone can be rotated and turned in the liquid. This makes it possible to observe the stone from different angles.

A horizontal positioning of the microscope is methodologically beneficial for these investigations. The liquid causes interfering reflections of the surface or stone facets to disappear, the inclusions then appear to float in the stone or liquid, see Figure 37. Immersion liquids with different refractive values (refractive index) suitable for the different stones are available from specialist dealers.



Microscopy with immersion liquid

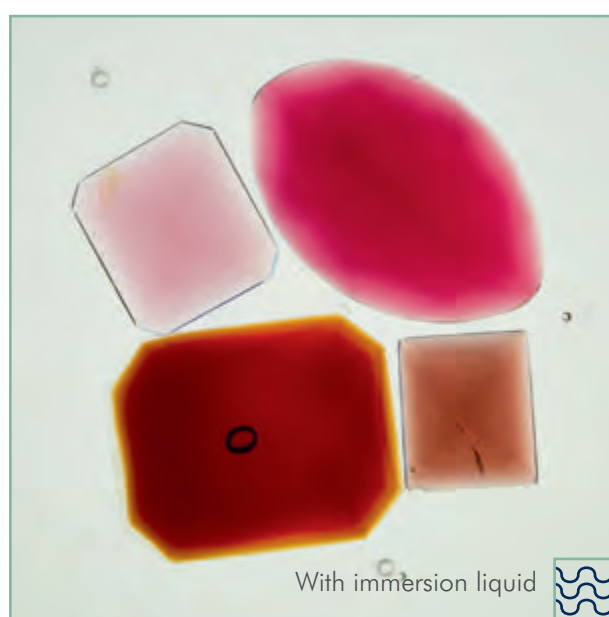


Fig.39: Four reddish stones illuminated from below (bright-field microscopy), above in air and below embedded in an immersion liquid (Benzylbenzoate,  $n = 1.57$ ). The facets disappear in immersion liquid, internal characteristics (inclusions) can be observed more easily.



## MICROSCOPY

### CHARACTERISTIC INCLUSIONS IN AQUAMARINE

If the professional prerequisites are met required level of experience has been acquired, inclusions (or internal structures) are able to provide valuable information about a stone. Figure 40 shows a light blue stone under dark-field microscopy with side illumination.

Some inclusions are so characteristic that their appearance provides an indication of the type of stone at hand. In our example, the existence of parallel hollow channels ("rain"), in a blue stone, are indicative for an aquamarine.

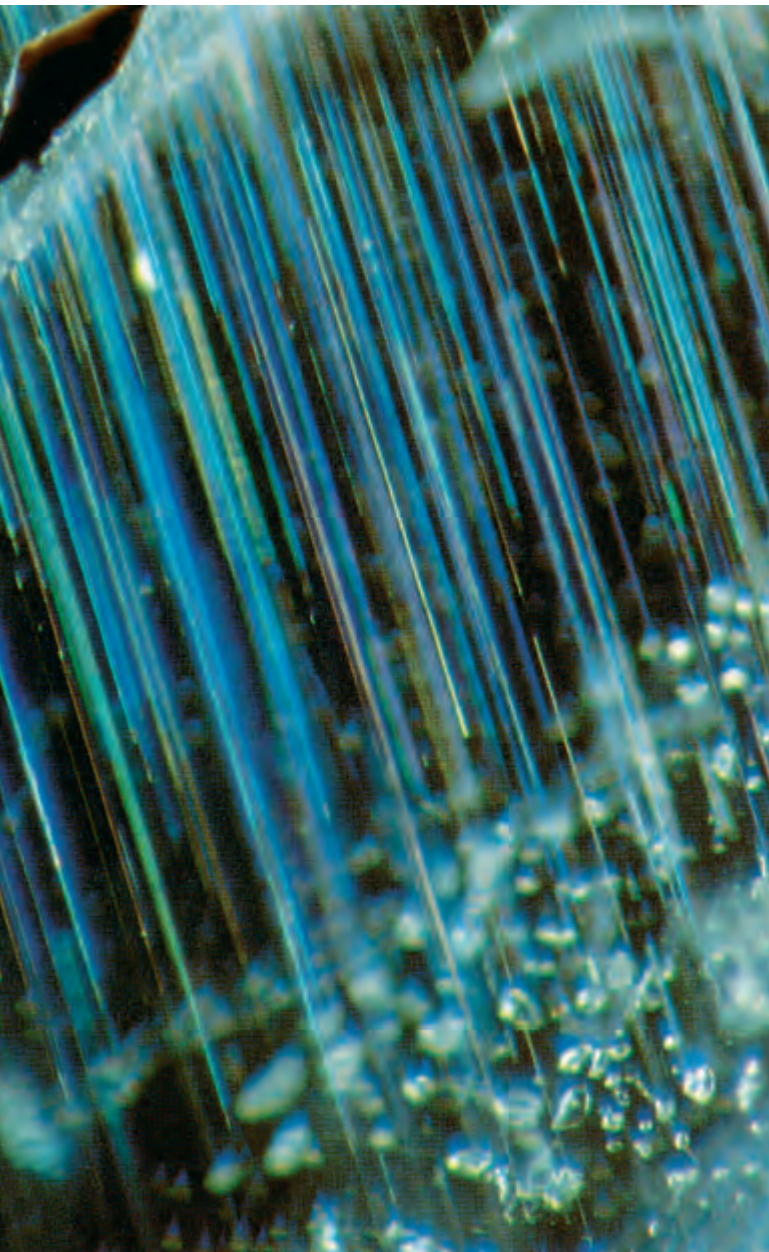


Fig.40: Hollow growth channels ("rain") in an aquamarine, magnification 35x. Photo source:  
© Friedrich Reinhardt Verlag/Basel - Photoatlas of Inclusions in Gemstones

### NATURAL OR SYNTHETIC RUBY?

Figure 41 shows a ruby examined under bright-field illumination with side shading.

Is the stone natural or was it created in a laboratory? Curved growth lines and the presence of gas bubbles immediately identify this stone as a synthetic ruby. It was manufactured according to the Verneuil process.

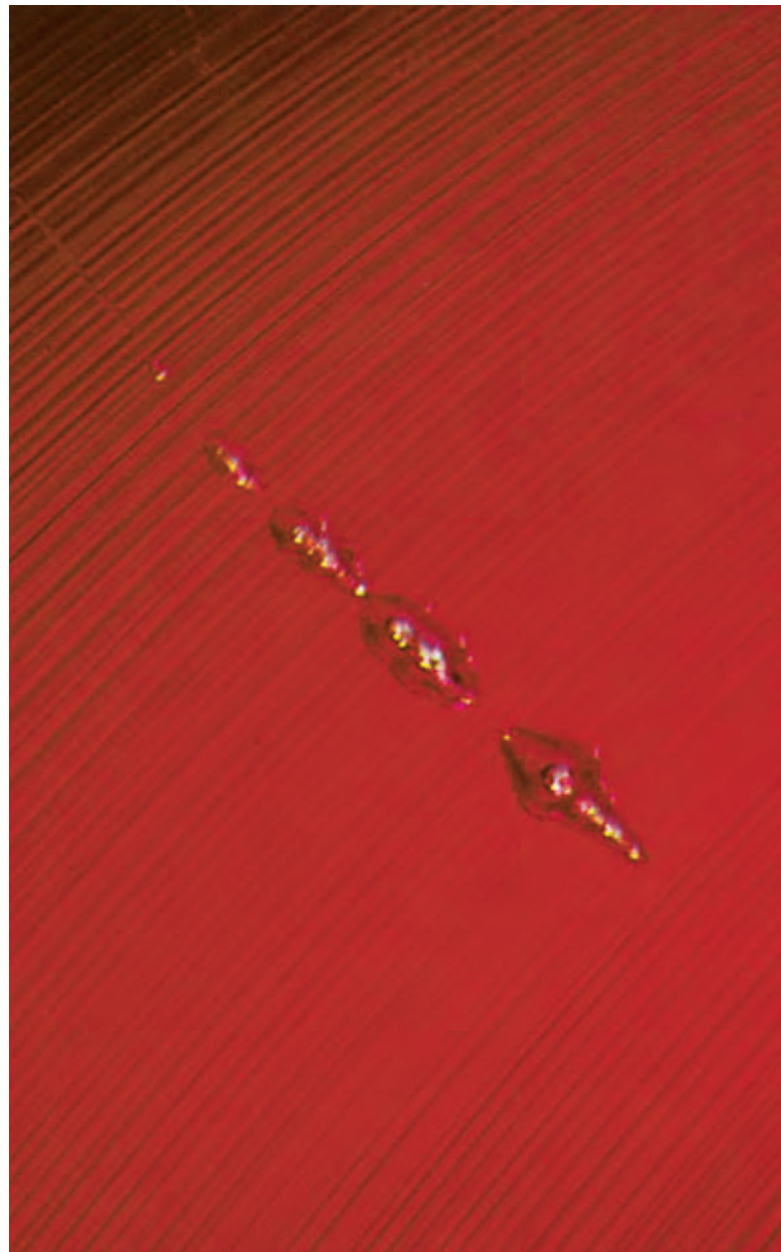


Fig.41: Curved growth lines and gas bubbles in a synthetic ruby characteristic of / typical for a Verneuil synthesis, magnification 50x. Photo source:  
© Friedrich Reinhardt Verlag/Basel - Photoatlas of Inclusions in Gemstones



## DETERMINATION OF PLACE OF ORIGIN BY INCLUSIONS

Figure 42 shows an emerald being examined with bright-field microscopy. The presence of three-phase inclusions in the emerald is not only proof that it is a natural emerald, for the place of origin is also revealed. It is an emerald from Colombia.

Inclusions may provide information on the deposit type or on the conditions of formation.

Actinolite needles in an emerald suggest a metamorphic formation and the pyrope in a diamond makes it possible to draw conclusions about pressure and temperature conditions during its formation.

## PLACE OF ORIGIN: SRI LANKA

Colourless round zircon inclusions with surrounding stress cracks in ruby (bright-field illumination, Figures 35a/35b) or long rutile needles crossing at  $120^\circ$  in sapphire (dark-field illumination with additional lateral illumination, Figures 37/38). The place of origin is also revealed: the stones come from Sri Lanka.

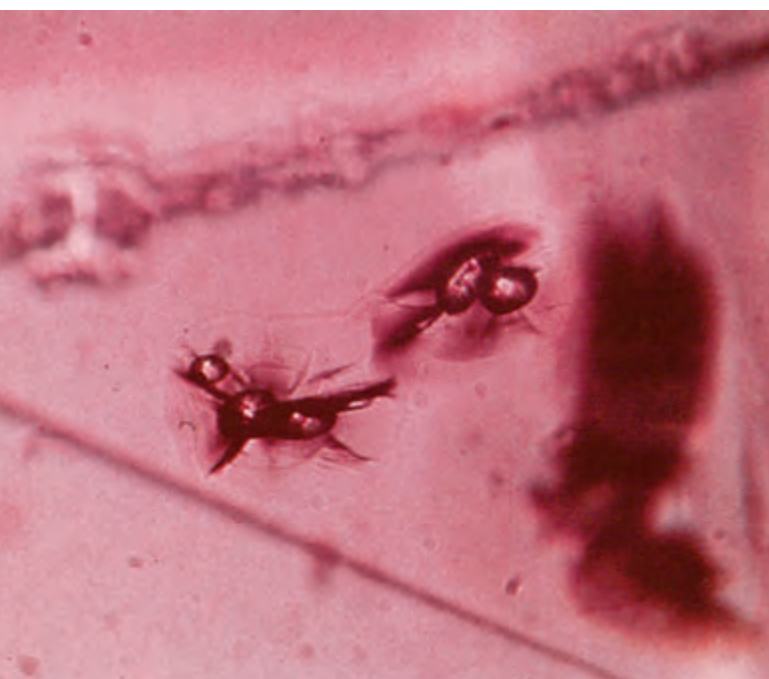


Fig.43: Zircon grains with stress cracks in ruby (volume increase in zircon due to isotropisation), Sri Lanka, magnification 20x. Photo source: © Friedrich Reinhardt Verlag/Basel - Photoatlas of Inclusions in Gemstones



Fig. 42: Three-phase inclusions (liquid, gas bubble, crystal) in an emerald, Colombia, magnification 50x. Photo source:

© Friedrich Reinhardt Verlag/Basel - Photoatlas of Inclusions in Gemstones

The purity of a diamond, the "clarity", i.e. the absence of inclusions, is ultimately a criterion for grading (valuation, 4 C). Gemstones that are virtually free of inclusions are generally considered to be of higher quality and are more expensive than those that have inclusions.

And last but not least: similar to the human fingerprint, the inclusion pattern of a stone is also its individual recognition feature.

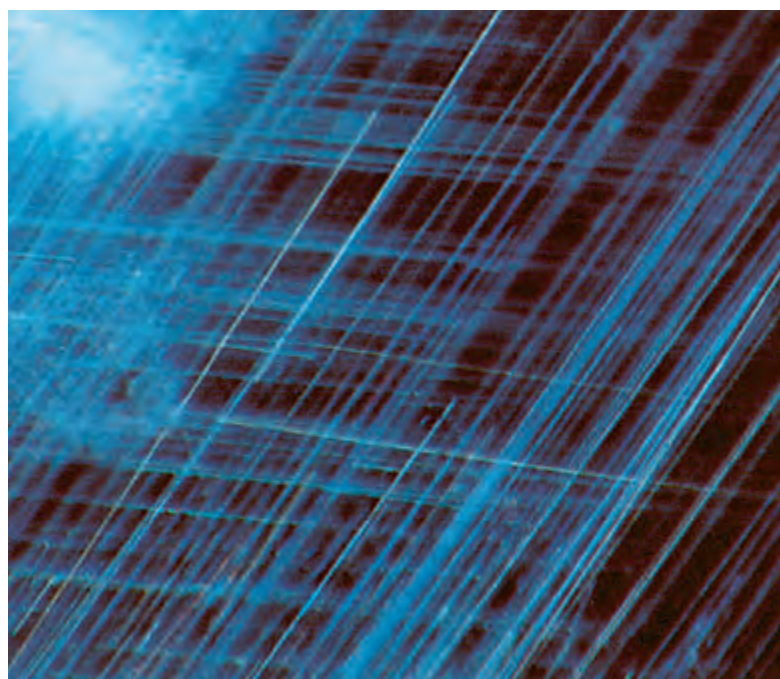


Fig.44: Oriented, long rutile needles ( $\text{TiO}_2$ ) in a natural sapphire, Sri Lanka, magnification 25x. Photo source:

© Friedrich Reinhardt Verlag/Basel - Photoatlas of Inclusions in Gemstones



## MICROSCOPY



### Stereo microscope with swivel arm and zoom for maximum working distance and flexibility

- Long working distance, extra-large field of view, brilliant resolution
- Colour fidelity and high depth of focus with high contrast
- Continuous magnification 7×–45×
- Third tube for the attachment of a camera e.g. for documentation and for generating quality reports
- With stand and swivel arm to adjust height and range individually for the sample observation
- With LED daylight ring for perfect illumination
- Without camera

ORDER NUMBER **MSZ5000-T-S-RL**



### Stereo gemstone microscope with zoom

With its large zoom range, long working distance and high depth of field, this powerful stereo microscope is perfect for examining gemstones, as well as minerals and fossils. With photo tube, incident and transmitted light, dark-field illumination (dark-field condenser) and rotatable stone holder.

- Continuous zoom with 7-45x magnification, expandable to 14-90x, when using 20x eyepieces and 2x auxiliary lens, a max. magnification 180x is possible
- High depth of focus
- 45° angled view, 360° rotatable
- 10x wide field eyepieces incl. eyecups, field number: 20
- Symmetrical eye distance adjustment 51-75 mm
- Diopter adjustment on both sides
- Object field 28.6-4.44 mm
- Working distance: approx. 90 mm
- Infinitely variable incident and transmitted light, dark-field condenser and photo tube
- Rotatable stone holder, preparation clamps
- Contrast plate glass and black/white, interchangeable

ORDER NUMBER **KSW5000-T-LED**

## OUR GEMSTONE MICROSCOPES



### Stereo gemstone microscope

- Basic configuration same as KSW5000
- Photo tube
- Horizontal alignment
- Cuvette for immersion liquid
- Cuvette table with rotatable stone holder
- Polarisation device and translucent glass
- Adjustable cold-light source with light guide
- Extension possibility for two-armed light guide
- With external mains adapter 110 V to 240 V

ORDER NUMBER

**KSW5000-T-K-W**



### Microscope camera MKTV5

- 5.0 Megapixel camera with 1/1.8" CMOS sensor
- Resolution of 2592 x 1944 pixels
- USB 2.0 hi-speed interface
- HDMI interface (HDMI cable included)
- USB interface for USB mouse or WiFi adapter (both included)
- Live image, image recording and video function
- Integrated software & additional PC software
- Storage of image and video files on SD card (included)

ORDER NUMBER

**MKTV5-C-MOUNT**

### MKTV5-display

- 11.8" 1080p IPS LC-Display
- Resolution of 1920 x 1080 pixels
- HDMI interface for connection to MKTV5 camera

ORDER NUMBER

**MKTV5-DISPLAY-C**



### Microscope camera Ace12

- 12.2 Megapixel camera with 1/1.7" CMOS sensor
- USB 3.0 interface
- Camera adapter with C-mount thread
- Live image, image recording and video function
- Basler microscopy software

ORDER NUMBER

**ACE12-C-MOUNT**

## OUR GEMSTONE MICROSCOPES



### Microscope camera Pulse5

- 5.0 Megapixel camera with 1/2" CMOS sensor
- USB 3.0 interface
- Camera adapter with C-mount thread
- Live image, image recording and video function
- Basler microscopy software

ORDER NUMBER **PULSE5-C-MOUNT**



### Mobile phone holder

Attach your mobile phone to a holder to create the perfect microscopic photo system.

- Adapter with eyepiece for the phototube of the microscope
- Suitable for all common smartphones
- Easily adjustable- with spring-loaded design clips
- Stable springs and pads, that hold and protect the mobile phone

ORDER NUMBER **MP-MOUNT**



### Stereo gemstone microscope

Microscope with incident and transmitted light, dark-field illumination (dark-field condenser) and rotatable stone holder.

- Magnification 10x and 30x, optional 20x and 40x
- 45° angled view
- 10x wide field eyepieces incl. eyecups
- Symmetrical eye distance adjustment
- Diopter adjustment
- 2-fold revolving nosepiece 1x and 3x
- Incident and transmitted light (LED)
- Dark-field condenser
- Rotatable stone holder and preparation clamps
- Contrast plate glass and black/white, interchangeable
- Power supply: 100 - 240 V
- Rechargeable battery for location-independent use
- Dust cover

ORDER NUMBER **KSW4000**



## OUR GEMSTONE MICROSCOPES



### Stereo gemstone microscope

Microscope in horizontal design especially for investigations with immersion liquids.

- Basic configuration as KSW4000
- Horizontal alignment
- Cuvette for immersion liquid
- Cuvette table with rotatable stone holder
- Polarisation device and translucent glass
- Adjustable cold-light source with light guide
- Extension possibility for two-armed light guide

ORDER NUMBER **KSW4000-K-W**



### Cold-light source

- Adjustable brightness without colour change
- 20 W halogen mirror lamp
- Colour temperature 3050 K
- With external power supply (switching mains voltage from 110 V to 230 V)
- Integrated adapter for spectroscopy lighting

ORDER NUMBER **KL5120-2**



### Daylight ring light with 72 LEDs

- Adjustable brightness
- Adjustable illumination direction
- Inner diameter: 27-60 mm
- Adapter ring: approx. 42.5 mm external thread
- With external power supply (switching mains voltage from 110 V to 230 V)

ORDER NUMBER **LDR72**

## TWEEZERS

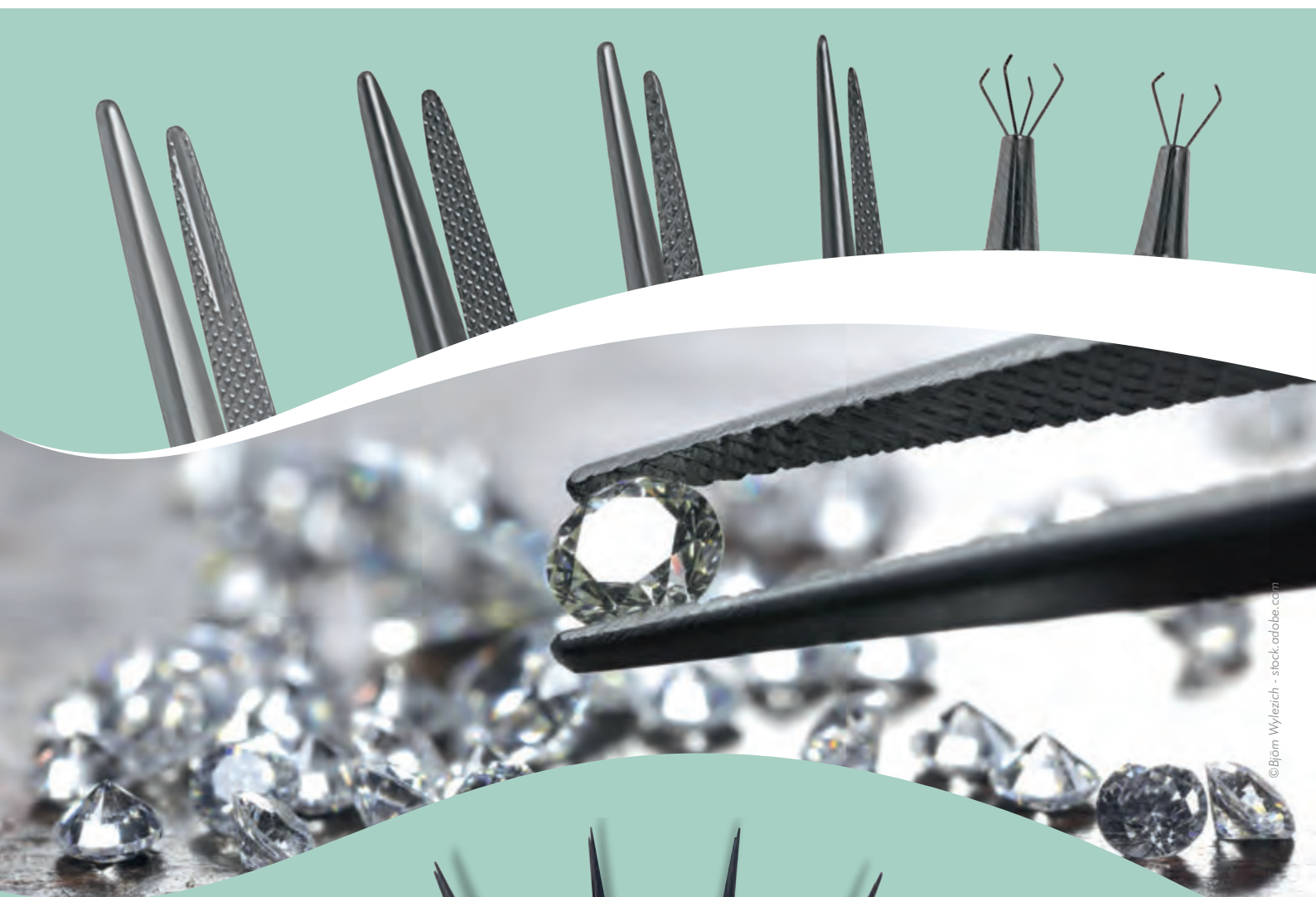
WITH GROOVE

LARGE

MEDIUM

FINE

STONE HOLDERS



© Björn Wylezich - stock.adobe.com



EDELSTAHL  
ODER TITAN

ORDER NUMBER	CLAW TWEEZERS
KOP30	Claw tweezer (3 claws): Length: 10 cm, colour: Silver, material: Brass chromed
KOP31	Claw tweezer (4 claws): Length: 10 cm, colour: Silver, material: Brass chromed
KOP32	Claw tweezer (3 claws): Length: 5 cm, colour: Silver, material: Brass chromed
KOP33	Claw tweezer (4 claws): Length: 5 cm, colour: Silver, material: Brass chromed

ORDER NUMBER	STONE TWEEZERS / SIZE F (FINE)
KO10F	Stainless steel stone tweezer: Length: 16 cm, colour: Silver
KO20F	Stainless steel stone tweezer: Length: 16 cm, colour: Black
KO30F	Titanium stone tweezer: Length: 16 cm, colour: Titanium grey
KOF10F	Stone tweezer stainless steel with locking device: Length: 16 cm, colour: Silver
KOF20F	Stone tweezer stainless steel with locking device: Length: 16 cm, colour: Black

ORDER NUMBER	STONE TWEEZERS / SIZE M (MEDIUM)
KO10M	Stainless steel stone tweezer: Length: 16 cm, colour: Silver
KO20M	Stainless steel stone tweezer: Length: 16 cm, colour: Black
KO30M	Titanium stone tweezer: Length: 16 cm, colour: Titanium grey
KOF10M	Stone tweezer stainless steel with locking device: Length: 16 cm, colour: Silver
KOF20M	Stone tweezer stainless steel with locking device: Length: 16 cm, colour: Black

ORDER NUMBER	STONE TWEEZERS / SIZE L (LARGE)
KO10L	Stainless steel stone tweezer: Length: 16 cm, colour: Silver
KO20L	Stainless steel stone tweezer: Length: 16 cm, colour: Black
KO30L	Titanium stone tweezer: Length: 16 cm, colour: Titanium grey
KO10LR	Stone tweezer stainless steel with groove: Length: 16 cm, colour: Silver
KOF10L	Stone tweezer stainless steel with locking device: Length: 16 cm, colour: Silver
KOF20L	Stone tweezer stainless steel with locking device: Length: 16 cm, colour: Black
KOF10LR	Stainless steel stone tweezer with locking device and groove: Length: 16 cm, colour: Silver





## MOBILE GEMSTONE LABORATORIES

One task within gemmology is to identify and analyse gemstones. The composition, authenticity, quality, origin and the treatment condition of the stones are examined with the help of high-quality analysis equipment. This frequently requires an on-the-spot inspection and calls for equipment that is mobile and ready for immediate use at any time. Experts can create assessments, analyses and gemstone valuations with the necessary precision instruments of our portable laboratories, regardless of location. They are also suitable for gemmological expeditions.



### Small mobile gemstone laboratory

The KA41KRS is a gemmological test laboratory, equipped with all standard instruments.

- Shock-resistant aluminium case
- Microscope KSW4000-K-W
- Microscope optics with 10x and 30x magnification (expandable to 20x and 60x)
- Vertical and horizontal alignment possible
- Dark-field lighting
- Gooseneck light guide for incident and transmitted light (incident light for microscope)
- Cuvette table with polarisation device and translucent glass
- Plane-parallel, polished glass cuvette
- Cold light source for incident and transmitted light
- Gemstone refractometer with sodium filter, polarisation filter and Anderson solution (refractive index: 1.79 nD)
- Hand-held spectroscope HS1501
- Polariscope
- Dichroscope HD10
- UV hand lamp
- Daylight lamp
- Sorting board
- Bottle for immersion oil
- Mains adapter 100-240 V, usable worldwide

ORDER NUMBER

**KA41KRS**

## AREA OF APPLICATION

A multiplicity of values can be determined for gemstones: These are replacement, insurance, wholesale and liquidation values. These values are often necessary in the context of private, legal and insurance transactions.

Gemmological expert advice is also frequently offered at trade fairs and auctions.

Mobile gemmological work is also necessary when experts want to conduct analyses directly at sites e.g. during geological excursions.



### Large mobile gemstone laboratory

The KA52KRS is a fully equipped, portable laboratory with precision optics, packed in a shock-resistant Rimowa aluminium case.

- Shock resistant aluminium case (Rimowa case with wheels)
- Stereo microscope MSZ5000 with zoom and German precision optics
- Microscope optics with magnification 7x – 45x (expandable to 180x)
- Intuitive touch screen
- Vertical and horizontal alignment possible
- Dark-field lighting
- Gooseneck light guide for incident and transmitted light
- Cuvette table with polarisation device and translucent glass
- Plane-parallel, polished glass cuvette
- Object pliers for set and unset stones
- LED lighting for incident and transmitted light
- Gemstone refractometer with sodium filter and Anderson solution (refractive index 1.79 nD)
- Hand-held spectroscope HS1504 with spectroscope holder and scale lighting
- Polariscope with analyser, polariser and conoscope lens
- Dichroscope HD10
- UV cabinet with short and long wave UV lamp
- Mains adapter 100-240 V, battery usable worldwide (running time approx. 8 hours)

ORDER NUMBER

**KA52KRS**

## A.KRÜSS OPTRONIC – QUALITY INSTRUMENTS FOR GEMMOLOGY



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Web [www.kruess.com](http://www.kruess.com)

A.KRÜSS Optronic has more than 220 years of experience in the development and manufacture of measuring devices. We manufacture our optoelectronic measuring and analysis instruments in Hamburg and benefit from a wealth of experience in a wide range of industries. In addition to the production of measuring instruments for laboratory analysis, we have been manufacturing and selling gemmological instruments used for the examination of gemstones for decades.

It has always been our ambition to be more than just a manufacturer, besides a vast array of services we also provide plenty of information on the basics, use and applications for inspecting gemstones. With a high standard of quality in production and development, the satisfaction of our customers has always been our main focus.

Gemmological measuring instruments from A.KRÜSS Optronic conform to international standards for investigations and measurements in the field of gemstone science. We stock the entire range of basic gemmological equipment such as refractometers, polariscopes, dichroscopes, spectroscopes, filters, UV lamps, loupes, tweezers, diamond testing devices as well as scientific instruments such as high-resolution precision microscopes and fully equipped mobile travel laboratories. Feel free to take a look at our web shop to find out more (conveniently scan the QR code shown opposite).

