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New Development in 2008:

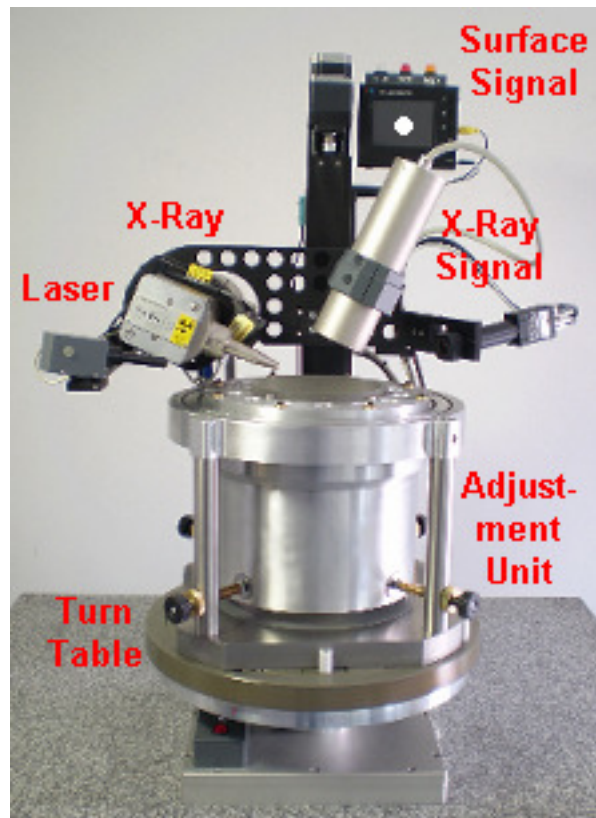
X-Ray Orientated Grinding of Sapphire Ingot Faces

Several sapphire processing steps rely on precise crystal orientation. Ingot end faces resulting from the initial core drilling are therefore mostly unacceptable and such raw ingots are usually post-processed to obtain end faces, and flats with the required precision in crystal orientation. X-ray orientated grinding is a cost-effective strategy to shorten the production time and number of steps and thus, has already been successfully applied by leaders in the crystal market.

EFG has developed the **X-Ray Orientation Machine for Sapphire (SAPG)**, an X-ray orientation measurement and adjustment system for up to 8" round sapphire ingots either specialized for c and r-orientation or more generally for c-, r-, a-, and m-orientations.

High-precision X-ray and laser measurements

Orientation measurements are based on the Ω -scan method [1]. An ingot is fixated in the adjustment unit mounted on a turntable. X-ray source and detector as well as the laser system have fixed geometry, whereas the measurement height is automatically adapted. During one rotation of the turntable, a complete Ω -scan is recorded and the crystal orientation is evaluated, all in typically less than 2 secs. The control program displays in its graphical user interface instructions how the adjustment screws have to be set. The whole adjustment unit is then transferred to the grinding machine where the desired flat surfaces are produced. After grinding, the resulting end face orientation can be re-checked. The orientation measurement accuracy is in the range of 10 arc secs.



Adjustment units with adapters for sizes from 3" up to 8" diameter

Ingots are fixated inside an adjustment unit. The image shows an 3" sapphire ingot mounted in a bigger adjustment unit using adapter elements.

Four adjustment screws are provided for orientation adjustment. The acceptable initial misorientation range is about 2° .



After an ingot is adjusted according to the X-ray measurements, the whole adjustment unit is transferred to the grinding machine.

Any known systematic errors from the grinding process may be corrected for in the calculated adjustment instructions.



Verification measurements

The image shows an 8" sapphire ingot dismounted from the adjustment unit after grinding. Part of an adjustment unit now carries a special plate for measurements of free-standing ingots. Such kind of measurement can be used to verify the parallelism of both end faces.

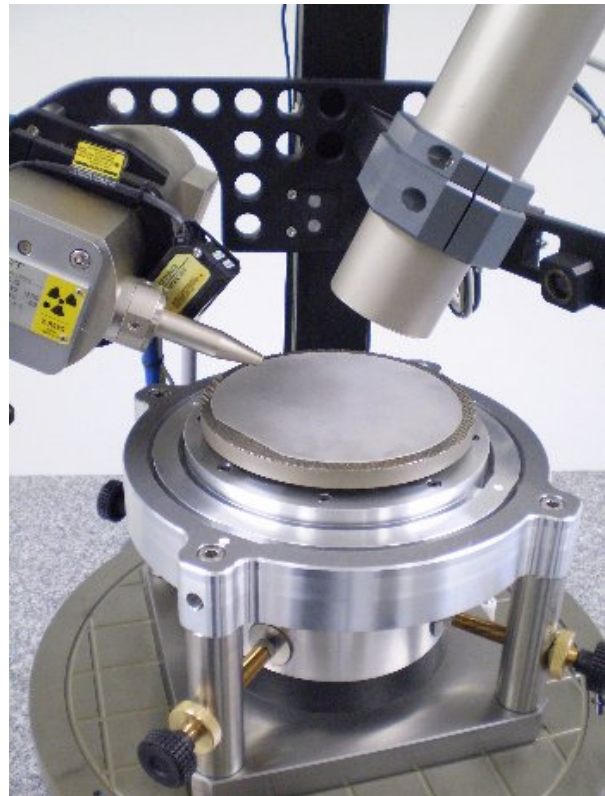


Wafer measurement and marking of directions

The image shows an 8" sapphire wafer placed on the measurement table. While the main task for the machine is ingot orientation, the machine can be used to perform standard Ω -scan measurements.

For flat specimen the laser system can be used to determine the tilt of the local surface normal.

A marking tool can be fixed to the stand (not shown). The turntable can then be set to any desired rotation angle and marks can be applied.



Technical data of basis system

Weight:	about 450 kg
Dimensions:	1.65 m x 0.87 m x 1.79 m
Required space:	area about 1.5 m x 3.0 m, height >2.0 m space for computer screen, keyboard, and optional printer handling space for assembly of adjustment units
Power supply:	230 V, 16 A, 50 Hz single phase
Cooling water conditions	4 l/min, 0.3 MPa pressure difference, maximum pressure 0.8 MPa, about 20 °C, clean water without any additives, inner tube diameter 8 mm

References

[1] H. Berger: "X-ray Orientation Determination of Single Crystals by Means of the Ω -Scan Method", J. Phys. IV France 118, 37-42 (2004).



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