X-ray Controlled
Ingot Stacking Machine

Reg.-No.: Q1 0403012

50 years experience in X-ray technology

Worldwide service and technical support

Introduction

For the wafer production of Sapphire, SiC or other crystalline materials, the ingots have to be stacked and glued together at a steal plate for the following cutting process.

The crystalline orientation of the ingots does not fit necessarily to the external shape. In some cases the wafer need an additional off-axis orientation.

So the stacking process has to be done ingot by ingot under X-ray control.

Furthermore there must be a mechanical tool to correct the orientation in a range of some degrees with an accuracy of tenth of arc minutes.

After completing the whole stack a steel plate has to be glued parallel to the selected stack axis.

This machine can handle ingots up to 4 inch diameter and stacks up to 300 mm. After the cutting the wafer orientation can be checked as well.

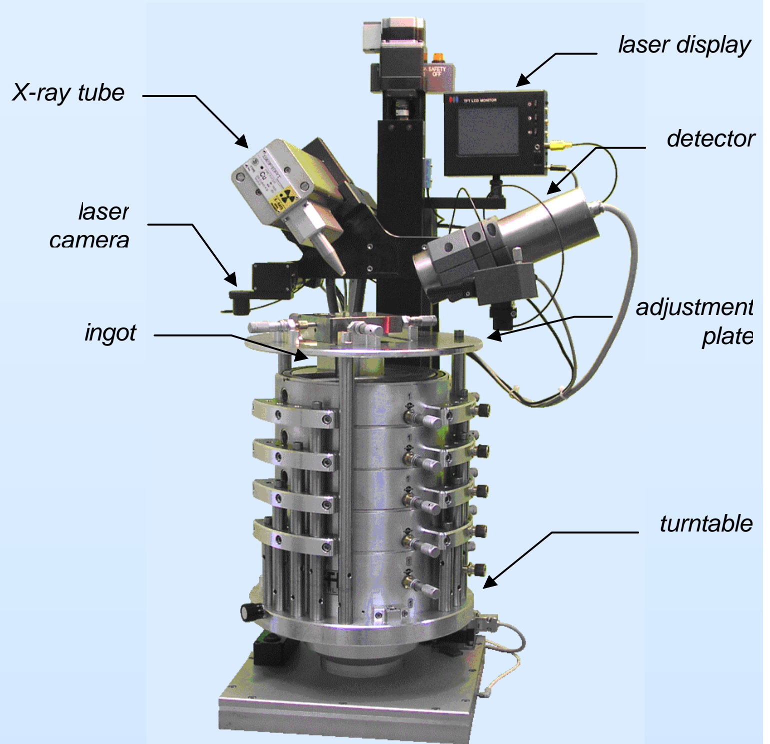

Fig. 1: Complete X-ray stacking machine

The X-ray control system

The Ω-Scan has been used for decades to measure the orientation of quartz blanks and wafers for sorting with an accuracy of few arc seconds.

Some hundred units are working around the world. The samples are put on a turntable, which rotates with a speed of about 0,5 turn/sec. The turntable must have a very high speed stability and a low, but adjustable wobble error.

According to Bragg's law the incident and the reflected beam have to be adjusted depending on the lattice parameter of the sample. A detector mask takes care for the selection of the required reflections (Fig.2, Fig.3).

The accuracy of the orientation depends mainly on the quality of the crystals. For high quality samples the accuracy is in the range of few seconds of arc.

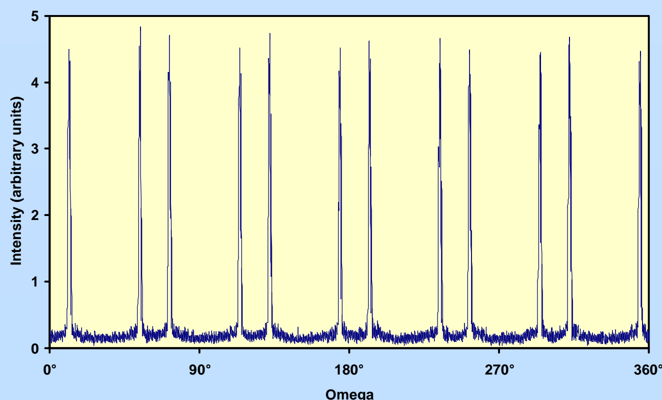

Fig. 2: Reflections of SiC

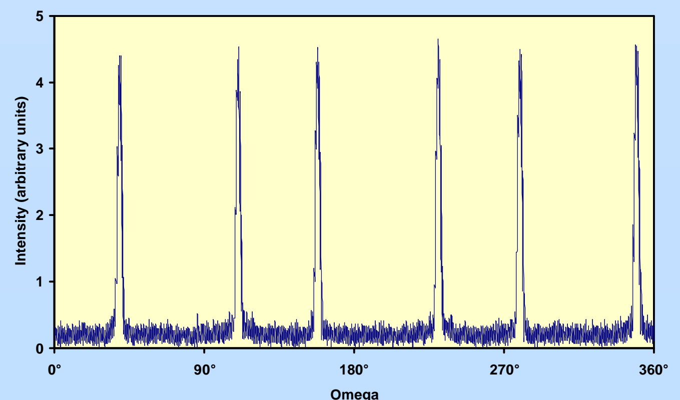

Fig. 3: Reflections of Sapphire

Stacking process

At first a plastic beam gets glued to each of the ingots. Then the wobble error of the turntable has to be adjusted mechanically to zero using the laser control system.

Now the first ingot can be put into the holder on the turntable (Fig. 4). Using a 360° rotation the ingot has to be adjusted in the preselected crystallographic direction by high precision screws. Normally 2 or 3 measurements are sufficient for the required accuracy.

After finishing the first ingot adjustment the second one can be put upon the first one and the adjustment of the second ingot can be done with the same procedure (Fig. 5).

After the last ingot has been adjusted a vertical adjustment element is put on the stack holder (Fig. 1).

Now the steel plate has to be smeared with a special glue, put into the slit and has to be pressed against the ingot beams. Finally it has to be adjusted by a rotation under the laser beam. After some fixing time the stack and the holder can be dismounted.

The height of the X-ray system at each measurement is adjusted automatically by laser control.

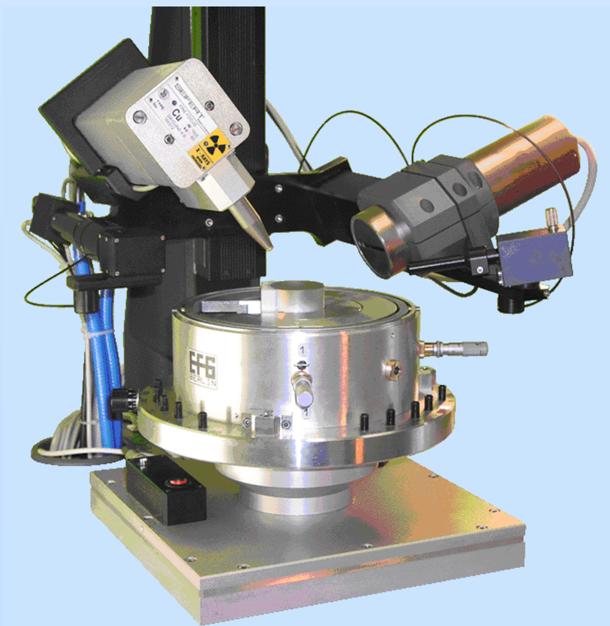

Fig. 4: Adjustment of the first ingot

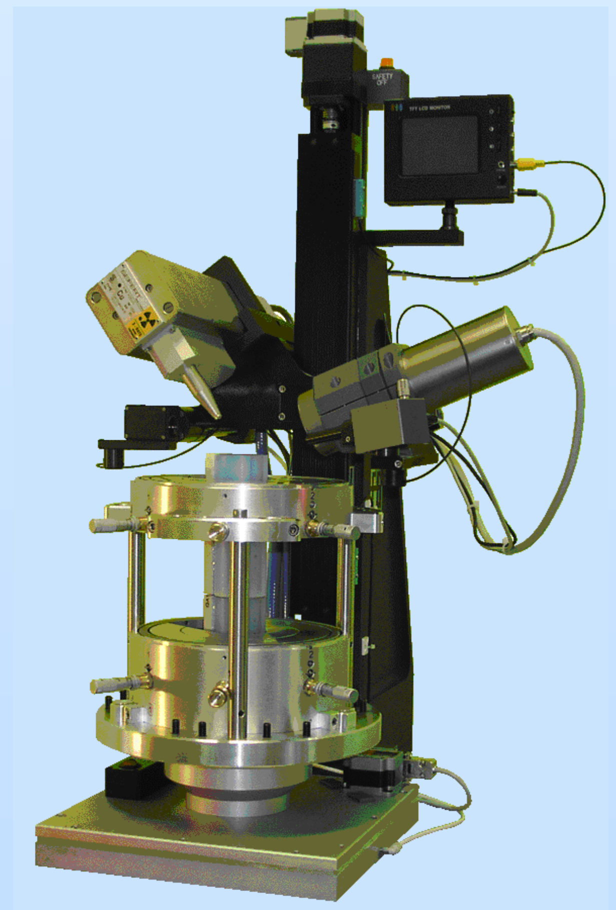

Fig. 5: Adjustment of the second ingot

Wafer checking

The orientation of the wafers, getting by the cutting process, can be checked with the same unit taking off the stacking system. If the quality of the surface is high enough, the laser system can be used to correct the wobble error. The height of the X-ray system at each measurement is adjusted automatically by laser control.

Specifications

Measuring system:

- 1.2 kW X-ray generator
- 1.5 kW scaled X-ray tube, Cu-target
- Usual tube conditions: 30 kV, 5 to 10 mA
- Focus 0.4 x 0.8 mm², beam diameter 1 mm
- Scintillation counter
- Laser system for surface-reflection measurement
- Safety plexiglass housing

Ingot stacking and adjustment system:

- Ingot diameter: 2 to 4 inches
- Ingot lengths: 50 to 150 mm
- Maximum stack heights: 300 mm
- Maximum adjustable off-axis orientation: 0.5°

X-ray measurement:

- Continuously rotating turntable, selectable number of rotations per measurement
- Measuring time (4 rotations of the turntable): 12 sec.
- Reproducibility (4 rotations of the turntable):
  Orientation measurement / ingot adjustment: 10 arcsec.
  Flat direction measurement: 30 arcsec.

Further EFG X-ray products

- Sorter for quartz blanks and wafers
- Wafer surface scanning unit
- Reflectometer
- Ingot orientation machine for silicon etc.
- Development according to customers' requirements

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