

Crystal Illuminations

A Publication of Sawyer Research Products, Inc. November 2000



In this issue:

Introduction.....	p.1
Mechanical Edge Grinding of SAW Wafers.....	p.1,2
Data Acquisition Systems for Autoclave Control.....	p.2,3
Teamwork Implements Quartz Growing Innovation.....	p.3,4

INTRODUCING "CRYSTAL ILLUMINATIONS" Janet Radwanski

Dear Readers,

Welcome to the first edition of "Crystal Illuminations", the Sawyer Research Products engineering newsletter. We will be publishing this newsletter from time to time to keep our customers and employees informed of our progress in research, engineering, product development and quality.

In addition to disseminating information, we would like our newsletter to become a forum for discussion and yet another way to generate a dialogue with our readers. We look forward to receiving your questions, comments and suggestions for future newsletters.

The Sawyer commitment to total quality is based on customer focus, employee participation and continuous improvement. We hope our newsletter articles will demonstrate to current and future quartz users that they can continue to look to Sawyer as the leading supplier of crystal products worldwide.

Mechanical Edge Grinding of SAW Wafers

Mac Anderson

Mechanical beveling of a Surface Acoustic Wave (SAW) wafer is an important process step that establishes several key final wafer characteristics, e.g., edge shape and finish, primary and auxiliary flat length and orientation and wafer diameter. These characteristics are extremely critical to the wafer end user since they improve wafer strength, insure proper device performance, aid in identifying wafer type and provide consistent features for optimum handling in automated tool sets. Proper edge beveling will also reduce chipping and particle generation from the wafer edge. Sawyer has adapted state of the art mechanical beveling tools to provide wafers to all SAW customers with consistent edge shape and finish while maintaining the tightest of tolerances on wafer diameter, flat length and orientation.

Early generations of SAW wafers were beveled using a chemical process to provide the final edge finish, wafer diameter and flat length. The chemical beveling process was labor and time intensive requiring waxing, a two step chemical soak in hazardous chemicals, dewax and an extensive final clean. Wafer diameter, edge finish and shape were hard to control and were not consistent from batch to batch. In the early 90's Sawyer began development of a mechanical beveling process using automated equipment and basic processing techniques proven in the silicon wafer industry. Special diamond wheels and wheel coolants were developed to provide the



STC edge grinder processing 4 inch wafers

(Continued on Page 2)

(Edge Grinding Continued from p1.)

optimum edge finish for quartz (the dominant SAW material at the time) without twinning the crystal at the wafer perimeter. In the mid 1990's, with a proven process developed and rapid growth forecast for SAW wafers, Sawyer committed extensive capital to its mechanical bevel capability and purchased the latest STC model mechanical beveling equipment from TSK. Improvements in edge finish, edge shape, diameter control, flat length and orientation control were dramatic with the installation and continuing optimization of this new tool set. By the late 1990's Sawyer Research was able to adapt these beveling tools to contour a variety of other SAW materials such as lithium tantalate and langasite while continuously improving the beveling process for quartz.

The STC model TSK edge beveling machine automatically bevels wafers from 76 mm to 150 mm in diameter. These tools have the capability to locate and grind multiple auxiliary flats with infinitely variable grind speed and removal per pass settings. The STC machines use parallel transport belts and small vacuum chucks to transport wafers from one operation to the next. The edge grind process is completed as follows: 1) The bottom wafer in the send cassette is selected and moved to the non-contact thickness probe station. Here the thickness of the wafer is measured so that the wafer middle can be located. An accurate location of the wafer middle insures a symmetrical contour of the wafer edge by centering the wafer in the groove during the grinding operation. 2) Next the wafer is transported to the diameter/primary flat measuring station. The perimeter of the wafer is scanned using an infrared sensor that

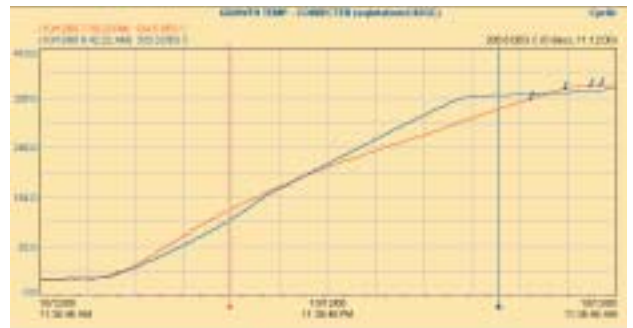
locates the exact position of the primary flat and provides perimeter information used by the machine to calculate the location of the radial center of the wafer. 3) A vacuum cup picks the wafer from this station and places it on the grinding chuck with the radial center of the wafer aligned to the center of the grind chuck. The wafer is moved into the grind wheel primary flat first and the primary flat is beveled to the specified flat length. Once the primary flat bevel is complete, the perimeter of the wafer and any auxiliary flats are beveled. During the beveling operation, coolant is sprayed at the groove-wafer interface to flush grind debris from the groove and to elimi-

nate heat build-up. 4) With bevel complete, the grind chuck moves away from the grind wheel and the beveled wafer is unloaded from the grind chuck with a vacuum cup and placed on a pair of parallel belts. These belts transfer the wafer to the receiving cassette. 5) When the cassette is full, it is replaced with an empty cassette and the cassette of beveled wafers is characterized for diameter, flat length and edge profile shape. Key consumables such as grind wheel groove and coolant are frequently monitored to insure they are replaced before they can impact the quality of a SAW wafer bevel. ■

Data Acquisition Systems for Autoclave Control

G. R. Kleckner

From the beginning of commercial crystal growth at Sawyer Research, there has been a need to gather information relevant to crystal growth, chart that information, make necessary adjustments to operating parameters and constantly monitor the progress of each autoclave run from start to finish. As the company grew, equipment was added to assist in the task of gathering this vital information. Specifically, internal and external vessel temperatures were monitored using Honeywell chart recorders, Dialatrol controllers and Hewlett-Packard series 9000 computers to insure the autoclaves operated within the necessary boundaries.



Temperature profile for autoclave startup

As computers became more powerful and less expensive, Sawyer realized there was a significant opportunity to address the vulnerability of these older systems (increasing maintenance burden, rapidly depleting supply of replacement parts, etc.) and to substantially upgrade our information-gathering capabilities. With cost in mind, a multi-phase replacement program was initiated which spread costs over a period of years and concentrated on the more critical components of the system first. In the late summer 1997 work commenced on the design and implementation of a replacement system for the Hewlett-Packard computers used to record internal temperatures in our autoclaves.

(Continued on Page 3)

Teamwork Implements Quartz Growing Innovation

Janet Radwanski

On 18Jul00, the US Patent Office issued Patent Number 6,090,202 to Dr. Vladimir Klipov, Senior Research Engineer at Sawyer Research Products. The patent concerns a unique way of restricting the growth of a quartz crystal so as to produce a "round" bar whose shape is more conducive to efficient commercial utilization. This is especially significant for fabricating large diameter SAW wafers.

The implementation of Vladimir's breakthrough idea into full-scale production highlights a few cornerstones of Sawyer's business and organizational philosophy. The first is that we believe in the courage to fail and the support in failure are essential to creating trust and to making progress through innovation and risk-taking. From the first restricted growth run produced in 1996, Sawyer management has been willing to support this innovation by devoting a percentage of production to making it work despite the impact of poor yields on autoclave capacity and financial results during the four years of development.

United States Patent [19]
Klipov



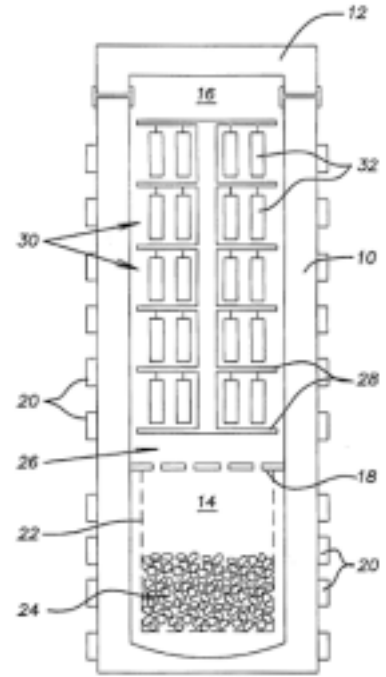
US006090202A

[11] Patent Number: **6,090,202**
[45] Date of Patent: **Jul. 18, 2000**

Secondly, two important Sawyer strategies in manufacturing and process technology are

1) team based manufacturing and engineering organizations and 2) a seamless interface between manufacturing and engineering. The implementation of such novel technology required participation at many levels in the manufacturing organizations both in Eastlake and Conroe. Employees in seed rack assembly had to learn how to handle more hardware and to position seeds in a more critical way. Employees in our lumbering operation that were used to dealing with square bars had to

(Continued on Page 4)



Autoclave schematic

(Data Acquisition Continued from p2.)

After researching several possibilities, a configuration was agreed upon and the project got underway in February 1998. Utilizing the Yokogawa DARWIN (Data Acquisition and Recording for WINDOWS) equipment, several desktop computers and INTOUCH software from Wonderware, the real work began. By mid-June 1998, the new Data Acquisition System (DAS) was in place and operational, completing phase I of the project.

Phase II of the project focused on replacing the out-dated Honeywell Dialatrol controllers. An important consideration in our choice of controllers was the desire to import the temperature of the external surface of the autoclave (skin temperature) into the existing DAS, thus providing detailed historical data for both skin and internal temperatures during the growth process. This combined data would provide a wealth of information for correlating operating conditions with crystal characteristics.

Once again, Yokogawa Corporation was selected and installation began using the new Green Series UT-350 controllers with a built-in RS-485 interface. This interface would be used to feed skin temperature data into the DAS. Phase II is now nearly complete both in terms of total controller replacement and software redesign for accommodating the additional information. New updated computers are being configured to handle the enormous amount of data being brought into the system and a centralized computer has been installed with a Wonderware INSQL program to collect and store this data for future use.

Phase III of the project will deal with computer control versus monitoring issues and whether or not computer control is the answer to minimizing process variation during quartz crystal growth. ■

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(Teamwork Implements.... Continued from p3.)

learn to grind and orient "round" bars while still maintaining the accurate reference surfaces expected by SAW wafer fabrication in Conroe. Conroe employees had to learn to mount and wire saw "round" bars while maintaining accurate orientations and sufficient flatness off the saw so subsequent operations would not be affected. It took a team effort to realize the full potential of an individual's groundbreaking idea.

We offer our sincere congratulations to Vladimir on receiving the patent for his break-through technology in

quartz growth. It has enabled Sawyer to better utilize growing capacity and to maintain cost-competitiveness in an electronics marketplace where products must always be smaller, cheaper and better. But we would also like to recognize the contributions of the many employees acting in cooperation that made full-scale production a reality. ■