Crystal Illuminations

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SAWYER RESEARCH PRODUCTS

In this issue:

INTRODUCING **"LITHIUM TANTALATE"**

Mark Polster

Dear Readers,

Since its inception nearly a half-century ago, Sawyer Research Products has been one of the world leaders in the area of synthetic quartz crystal growth. Though our business and technology has continually evolved throughout our rich history, we have, for the most part, been primarily a quartz company. At this time, we are pleased to announce the start of a new chapter in the Sawyer story – the introduction of lithium tantalate crystals and wafers. Though lithium tantalate is already widely used, for Sawyer this represents an exciting new beginning as we expand our scientific and operational base to incorporate Czochralski melt growth techniques. In this issue of Crystal Illuminations we are pleased to introduce some current and planned initiatives in the areas of LT growth and wafer fabrication.

SSKT Shanghai Facility

Sawyer has maintained an integrated approach encompassing the full gamut of operations from crystal growth through all stages of wafer fabrication. Production scale crystal growth has been developed at Sawyer Shen Kai Technology Co. (SSKT), a Sawyer joint venture located near Shanghai. Our joint venture partner, Dr. Shikay Yao, holds a PhD in Optics from Carnegie Mellon University and brings not only a wealth of experience in managing high technology businesses, but also specific experience as a SAW device designer. In addition to SSKT's production capability, Sawyer has also installed several full-scale research-oriented crystal growth furnaces at a development facility located at our Eastlake, Ohio headquarters (see article on page 2).

At our Conroe, Texas wafer fabrication facility we have adapted our state-of-the-art quartz wafer fabrication process for LT. Our extensive experience fabricating quartz products combined with the latest wafer fabrication and characterization equipment enables Sawyer to achieve even the most demanding wafer specifications (see article on page 3). Sawyer has also assembled a team of materials science and crystal growth experts to continually improve and advance all facets of our technology.

As with our quartz products, Sawyer is committed to the highest standards of quality products, technical expertise and customer support as we embark on this exciting new endeavor. We look forward to your participation and feedback. ■

$LiTaO_3$ PILOT MELT GROWTH FACILITY

Matt Whittaker

Sawyer Research has always believed that providing the highest quality product is the key to success. The company also understands that quality and consistency do not develop accidentally. Through close cooperation with our customers, and numerous joint R&D projects, Sawyer played an integral role in the development of quartz SAW wafers.

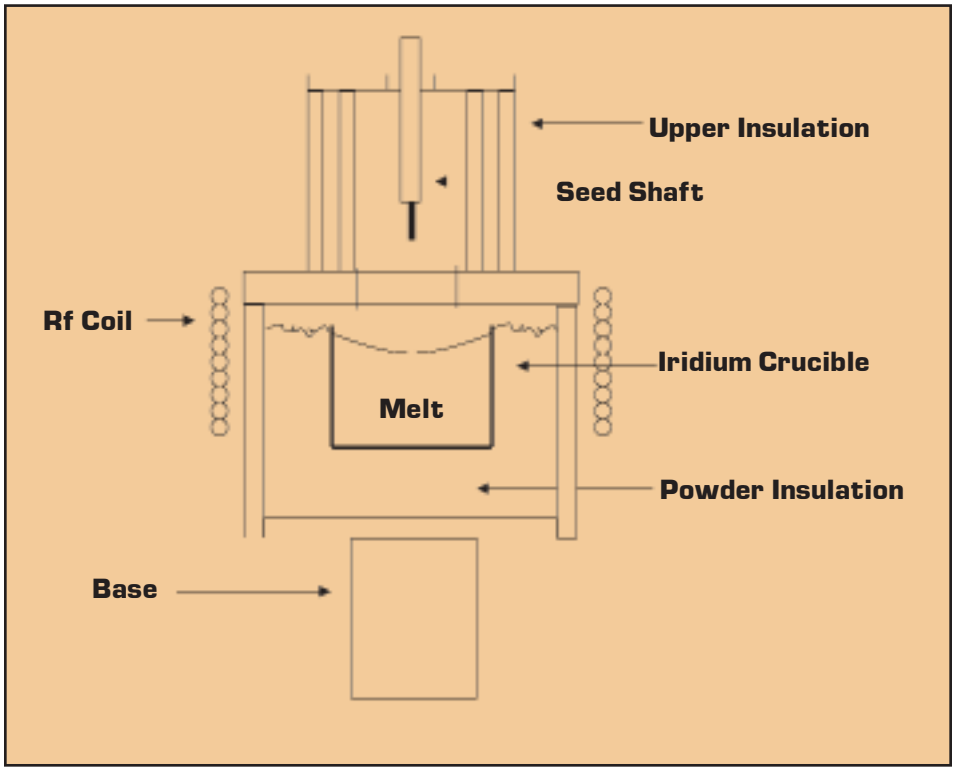
Building on the recent successes of 3-inch and 4-inch $LiTaO_3$ boules for SAW wafers from our joint venture in Shanghai, Sawyer Research Products is finishing construction on a Czochralski growth pilot plant at its headquarters in Eastlake, Ohio. The new growth facility will be a multi-purpose R&D and limited production facility to optimize $LiTaO_3$ properties for various applications. One of the primary tasks for this pilot plant is to further improve the homogeneity of our current $LiTaO_3$ SAW crystals by optimizing the crystal growth conditions.

While we currently produce and supply $LiTaO_3$ wafers for SAW applications, we understand that the demands of optical devices require different crystal properties and specifications. We are developing $LiTaO_3$ crystals for the most demanding optical applications. We anticipate that Mg doping will become necessary to increase optical damage threshold, and that stoichiometric crystals will begin to replace $LiNbO_3$ in many high-power laser applications. Our goal is to develop homogeneously doped crystals with the lowest absorption to meet the most demanding modulators and SHG device specifications. In addition, other specially doped crystals to meet particular customer demands may also be grown at this facility.

The new R&D facility will provide state-of-the-art research facilities to support our joint venture in Shanghai. We have access to the latest generation of photospectrometry, mass spectrometry, optical, and thermal characterization equipment.

Development of larger diameter $LiTaO_3$ crystals will be undertaken to keep up with demands placed by the scaling up of device photolithography systems. As we have with quartz, Sawyer plans to stay at the forefront of any new size increases.

The Czochralski growth stations are custom built, in-house, utilizing our own design and control systems. Our systems operate via induction heating of iridium crucibles. These growth stations will allow research into, and production of, crystal systems with melting points approaching 2200 ^{0}C to meet a wide range of future customer demands. ■



Melt Growth Diagram

FABRICATION OF LITHIUM TANTALATE

Tyson Kennedy

In August of 1998, Sawyer implemented a lithium tantalate fabrication strategy with the goal of establishing ourselves as a world class lithium tantalate wafer supplier. The essence of the strategy meant the fabrication transition of lithium tantalate wafers from the R&D department to standardized production lines. In order to implement our strategy, numerous fabrication issues had to be addressed.

"Sand Blast" Equipment

The first step in producing a high quality wafer is the wire saw operation. Sawyer implemented programs directed specifically at optimizing wire thickness, wire speed, and slurry delivery for lithium tantalate boules. The result has been reduced kerf loss, minimized surface damage, and optimized attributes of Bow and Warp.

The edge grinding operation establishes the diameter of the wafer and provides our customers with a wafer ideally suited for state-of-the-art SAW device manufacturing equipment. Engineering efforts were successful at achieving the desired profile with minimal chipping and edge fracture.

In the R&D department low capacity lapping machines were utilized. As quantities increased, lithium tantalate wafers moved to higher capacity machines with automated thickness gauges to achieve consistent target flatness.

Customer feedback on initial samples indicated the desire for a variety of backside Ra values. In response to our customers' requests, Sawyer added "sandblast" equipment in mid-2000. The automated equipment roughens the backside by using a high-pressure mixture of compressed air and media for controlled material removal. Today, Sawyer has the additional flexibility to produce various backsides while maintaining excellent wafer flatness.

The largest challenge Sawyer faced during the transition was how to achieve a reliable etch process for high production quantities. The process is very time consuming and the higher volume production requires increases in safety assurances. Engineering focused on the critical process control characteristics and the necessary safety parameters. The result is a state-of-the-art etching system that combines excellent process control with a high degree of safety. Full control of all etch parameters has been established including high temperature caustic solution control.

Lithium tantalate polishing was first developed on internally automated SpeedFam polishers. The process has evolved to include polishing on a Double Sided Polisher (DSP) or on Sawyer's newly implemented, high capacity, customized semi-conductor polishing equipment dedicated to lithium tantalate wafers only. Significant improvements in the polish process have contributed to the reduction of process times, which strongly correlates to improved wafer flatness characteristics.

It should further be noted that while fabrication improvements were being made at Sawyer, significant material

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Sawyer's State-of-the-Art Etching System

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(Fabrication of Litium Tantalate.... Continued from p3.)

initiatives were also achieved. SSKT boule diameter steadily increased from 2-inches to 3-inches and then to 4-inches. Uniformity of poling was achieved and continues to be optimized. Seeds for specific angle growth were implemented, with a selection range from 36 to 42 degree. Z-cut optical material and 112 degree X-cut material have also been developed. Curie temperature has been improved with the addition of automated control monitoring systems to insure Curie temperature stability of +/- 2 degree C.

Full-scale fabrication of lithium tantalate wafers has been an exciting challenge at Sawyer. We continue to seek our customers' feedback on both short-term and long-term needs of our world class lithium tantalate wafer. ■

Customized "Semiconductor" Polishing Equipment For LT