

PyroFree™ Processing for Lithium Tantalate



**SILICON
LIGHT
MACHINES**

A **SCREEN** COMPANY

PyroFree™ Technology



- **Lithium Tantalate (LiTaO_3 or LT) wafers are used primarily for the fabrication of SAW filters used in cell phones**
- **Fabrication of SAW filters is impeded by the pyro-electric nature of LT (the pyro-electric effect is where a voltage builds up as the wafer is heated, resulting in a spark which damages the device).**
- **SLM has developed a process for eliminating the Pyro-electric effect in LT, rendering them PyroFree™ . The process is patented (USP6,932,957, USP7,527,755) .**
- **This process is performed on LT wafers after they are cut and before they are polished**

Advancements in LiTaO₃



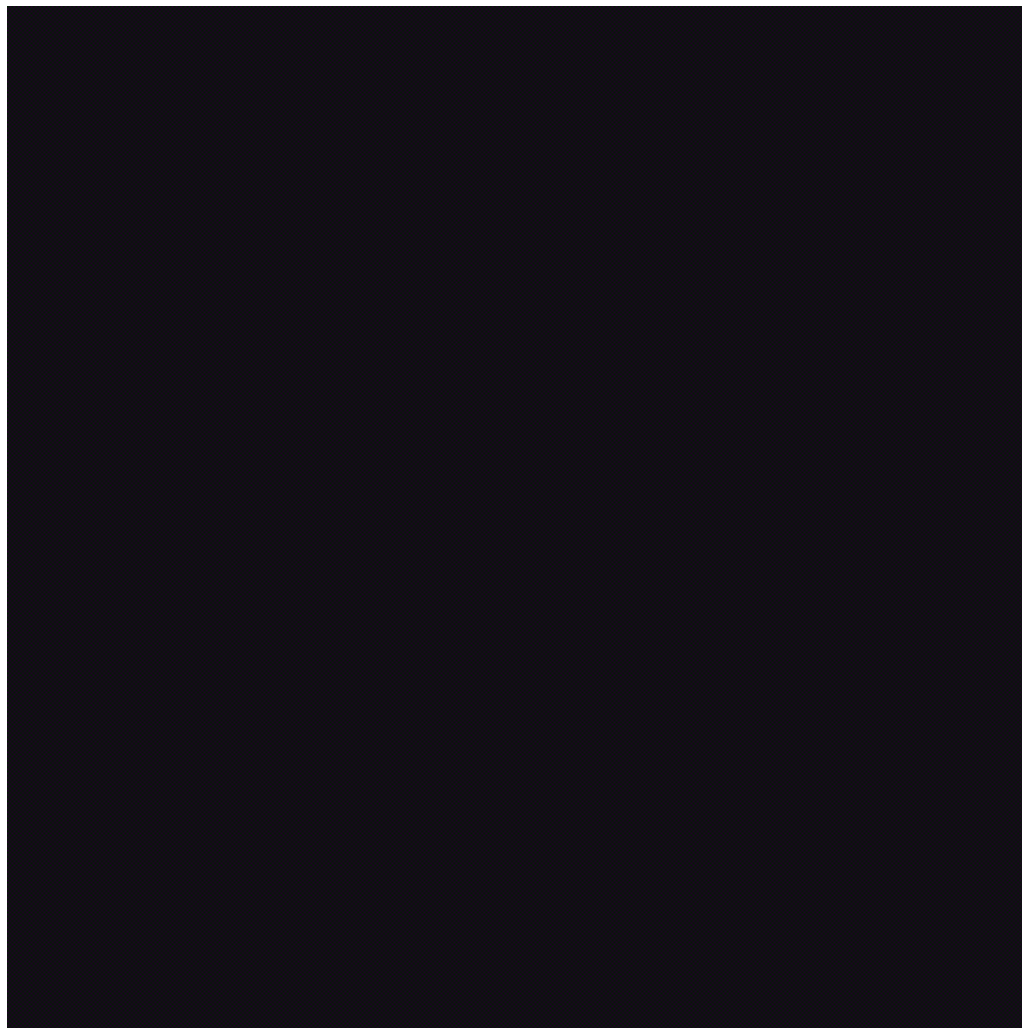
- **PyroFree™ Processing**
- **Domain Patterning Technology**
- **Waveguide Technology**
- **Photorefractive Damage Resistance**

Ramping temperature of PyroFree™ and standard LT wafer sections



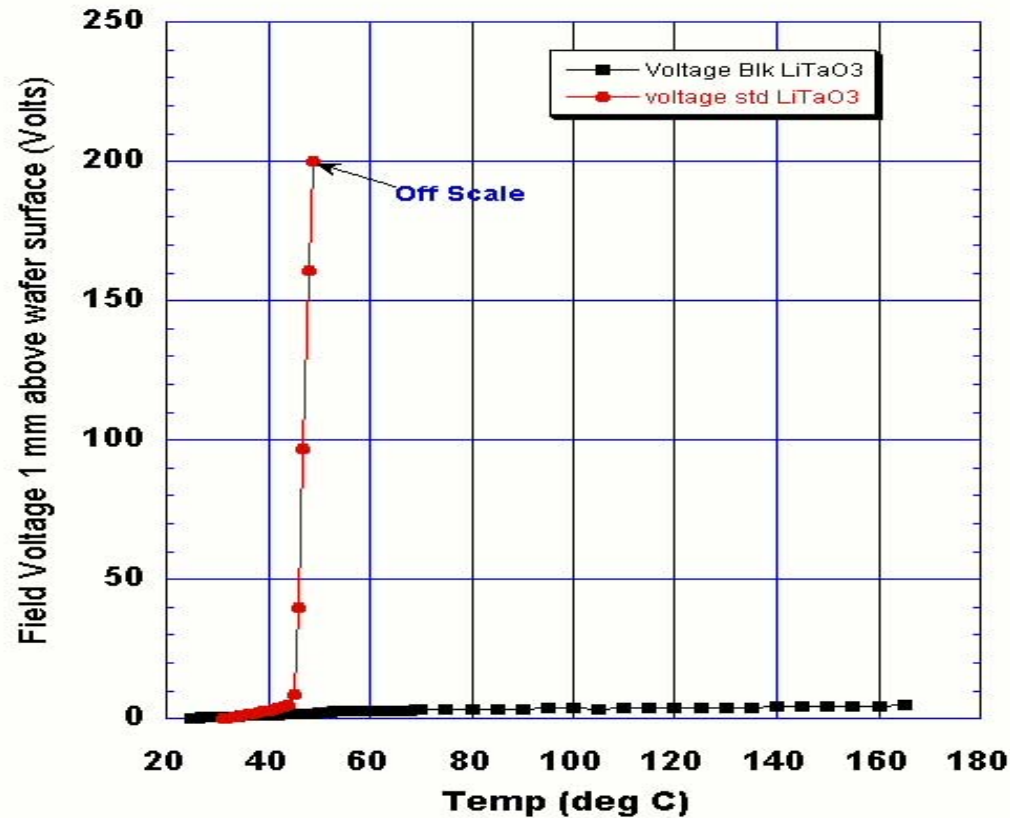
- Please see embedded movie on next slide (as well as on the website) that demonstrates the capability of SLM's PyroFree™ treatment of Lithium Tantalate wafers
- Raw, untreated Lithium Tantalate (LT) wafers are pyroelectric and arc during thermal cycling that normally occurs during a SAW manufacturing process. This sparking damages or even breaks the LT wafer
- SLM shows experiments in which the left side on a LiTaO_3 wafer remains untreated while the right side is “blackened” – treated with SLM's proprietary PyroFree™ process. During temperature cycling in both increasing and decreasing temperatures, the movie shows sparking in the untreated section of the LT wafer while the treated portion remains conductive (with no sparking).

Ramping temperature of PyroFree™ and standard LT wafer sections



Conductivity

Comparison of Surface Charging Between
42RY Standard and Pyro-Free LiTaO3



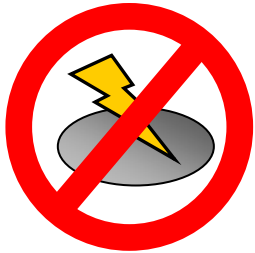
Process notes for PyroFree™ LiTaO₃



Performance Specifications

Property	Pyro-Free LT Value* (36° RY cut)	Standard LT value (36° RY cut)
Bulk Electrical Conductivity	Log (σ in $\Omega^{-1}\text{cm}^{-1}$) = -11.3 ± 0.4 (typical)	Log (σ in $\Omega^{-1}\text{cm}^{-1}$) = -16 ± 1
Effective Pyroelectric Coefficient	$p < 1 \text{ pC cm}^{-2} \text{ K}^{-1}$	$p = 11 \text{ nC cm}^{-2} \text{ K}^{-1}$
Curie Temperature, T_c	Unchanged, within $<1^\circ\text{C}$ of standard T_c	$603 \pm 3^\circ\text{C}$
Ferroelectric Domain Structure	Single domain	Single domain
Color	light gray throughout depth of wafers	colorless
Piezoelectric Coupling Coefficient, k_{eff}^2	Unchanged, within $<0.1\%$	5.0%
SAW velocity	Unchanged, within 10 m/s	4160 m/s
<p>🔴 Preliminary values for initial product</p>		

Pyro-free LiTaO₃ Benefits (Value Proposition)



● SLM's PyroFree™ Technology enables:

- Manufacturing of SAW filters free of temperature induced voltage spikes
- Reduction in wafer loss during processing of SAW filters
- Shortened manufacturing cycle time for higher throughput
- Higher quality SAW filters to address growing markets