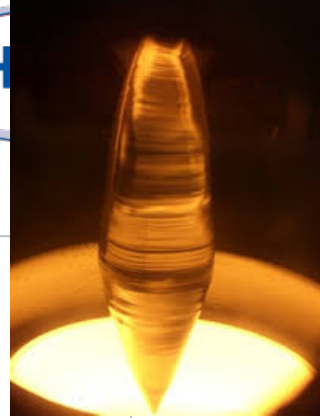


Workshop on Applications of Thermal Management Materials

**Piezoelectric Crystal for
Temperature Measurement
up to 500°C**



Crystal innov

WHAT : A technology institute for innovation in crystal growth, process and applications

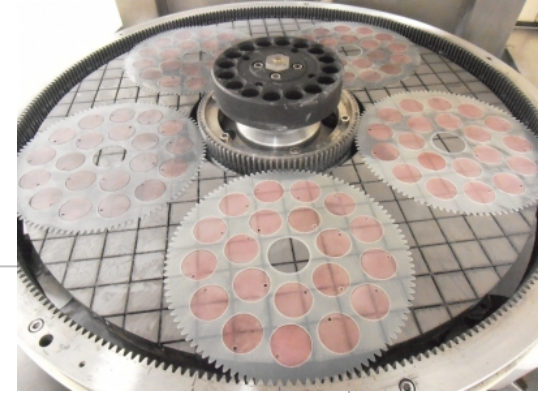
WHERE : in France, between Lyon, Geneva and Grenoble

WHO :

- a public / private consortium, with SME and academic lab working on process, devices, applications and equipments based on Crystals
- A team of specialists, working in close relationship with some researchers and R&T engineers

WHY : to make innovation easier and faster in a manufacturing sector (Crystals), especially from lab to start-up and SMEs





Crystal innov



GROWTH :

Bulk : Cz, hydrothermal synthesis

Fiber : micropulling

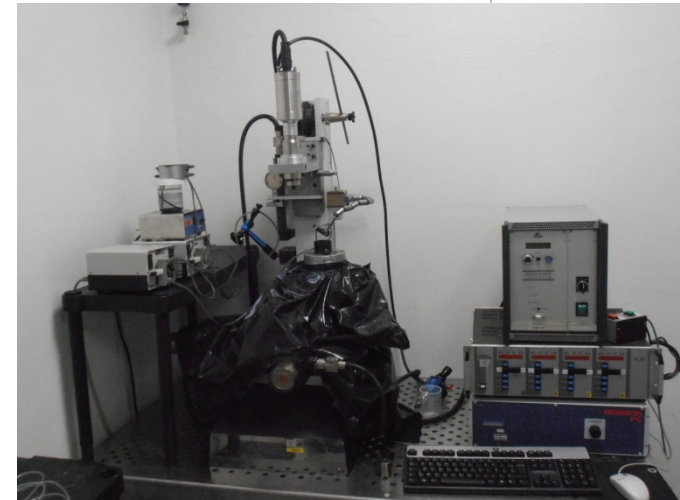
Film : CVT process development in progress

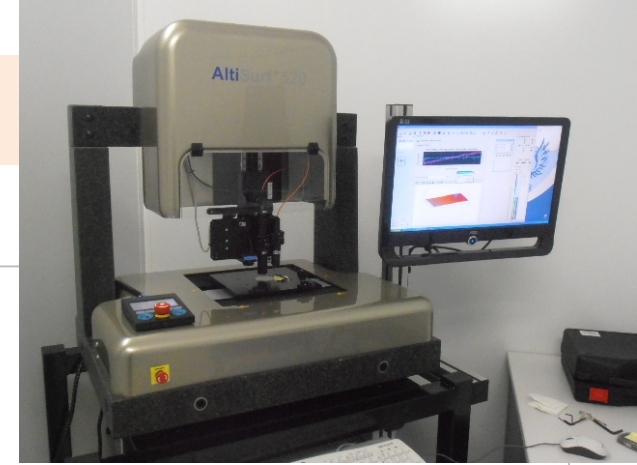
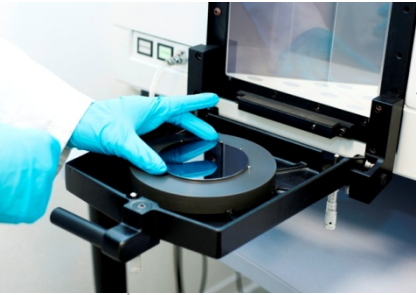
PROCESS :

Grinding, wafering (**diamond multi wire saw**)

Lapping, polishing (**double face, up to 200 mm**)

micro-machining (semi automatic **ultrasonic drilling machine**)





CHARACTERISATION :

X-Ray : orientation and crystal structure

Surface measurement : Interferometry & chromatic confocal sensor

Diffractometry + access to a **LIBS**

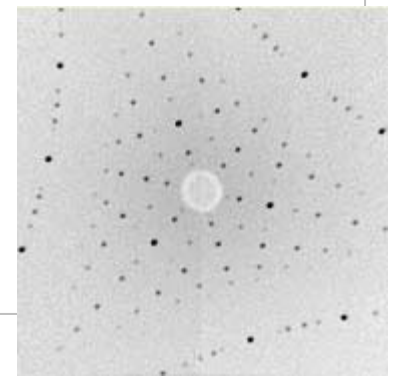
FACILITIES :

1.500 m² technical surfaces (allocated to both private box and open space)

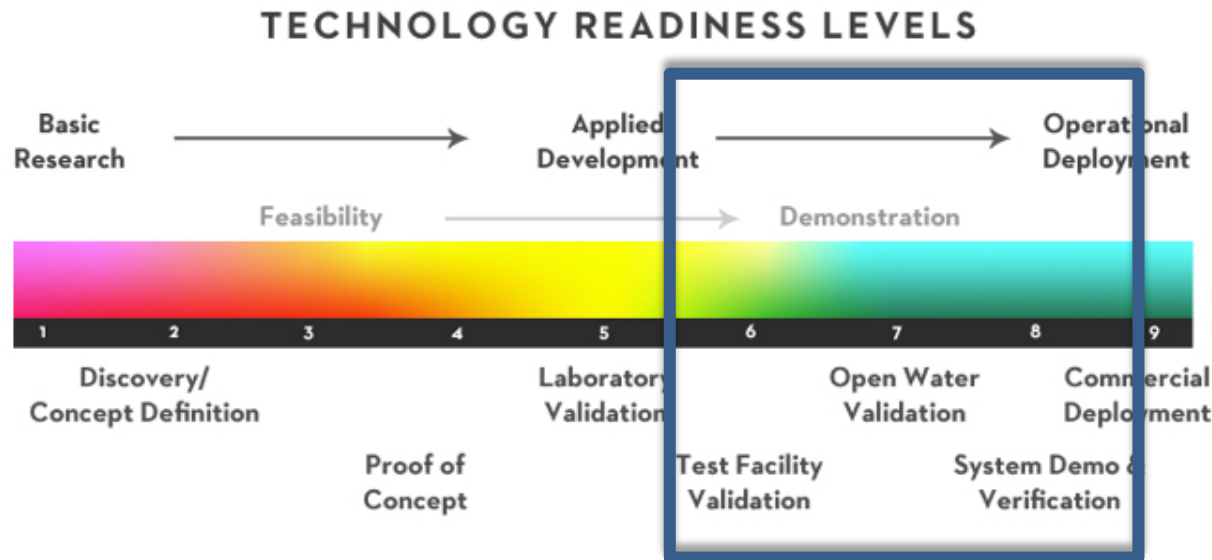
High tech industrial facilities

Cleanrooms : ISO class 5 to 8

+ Access soon to a technology FabLab in construction



Projects hosting and management – co-innovation :
R&T projects, Process development, pilote line...



Access to equipments

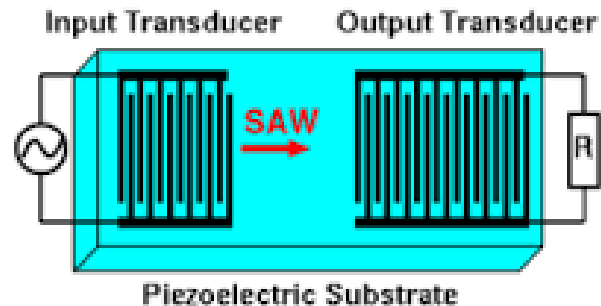
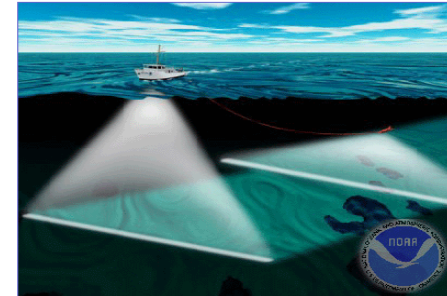
Services in machining (e.g. sample & wafer preparation) and characterization

High performance piezoelectric Crystals and components

*Resonator for USO
(Ultra Stable Oscillator)*



*Sonar with
Ultrasonic freq*



Piezoelectric Substrate

- Fewer producers in Europe
- Some strategic materials for space, R&D infrastructures and defence
- New applications / potential of innovation
- Process reengineering

Figure of merit comparison

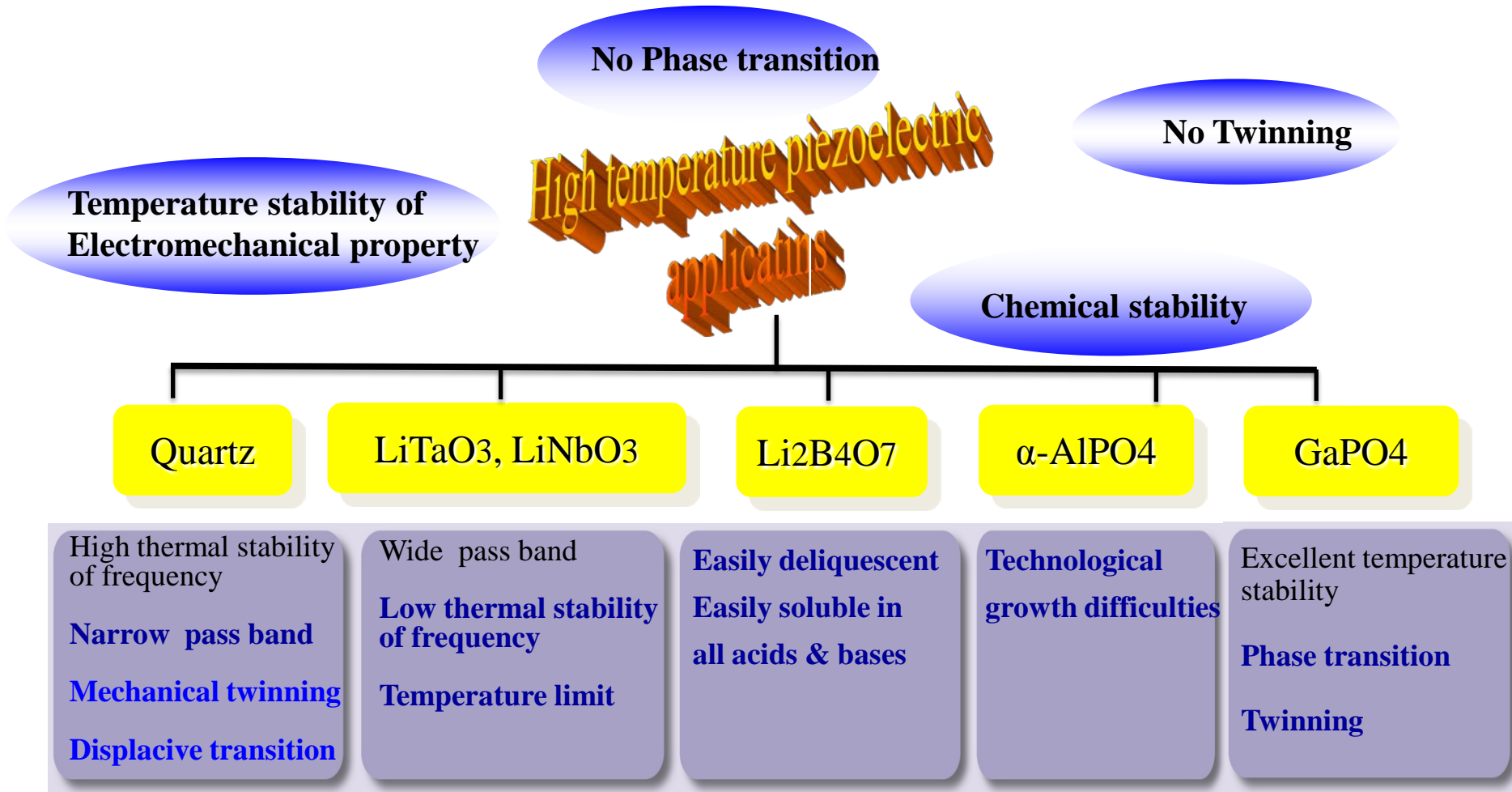
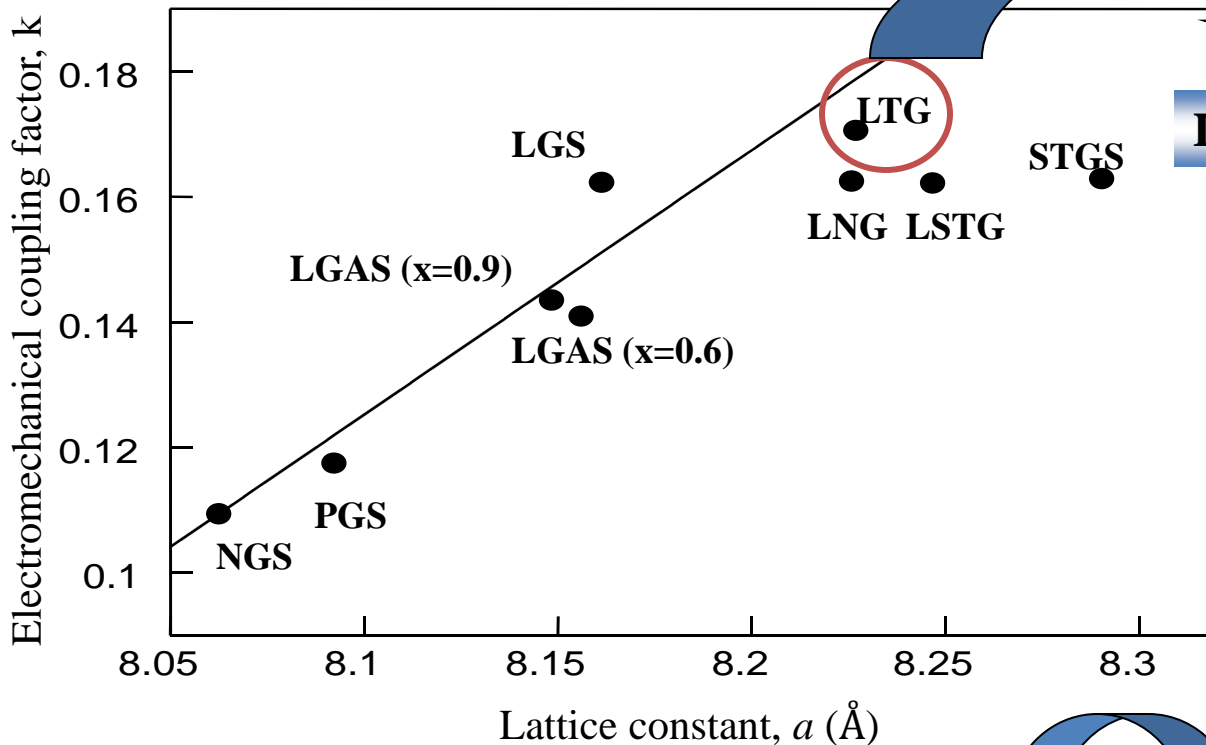


Figure of merit comparison

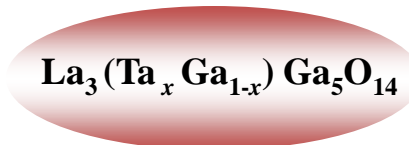
Single Crystals											
Material	FE*	Structure	Sensitivity / pC/N			$\rho / \Omega.cm$	Q_m	Temp. Stability	$T_c^{**} / ^\circ C$	Max Op. Temp. / $^\circ C$	
				d_{33}	d_{11}						d_{15}
α -Quartz	No	α -Quartz	Low	-	2.3	-	High 10^{17}	10^5	High	573	300
GaPO ₄	No	α -Quartz	Low	-	4.5	-	High	10^5	High	930	930
Langasite(s)	No	-	Low	-	<9.0	-	High	$7.5-20 \times 10^3$	High	1470	1470
LiNbO ₃	No	Corundum	Low	1.6	-	7.4	Low 10^4	$1-3 \times 10^3$	Med.	1200	1200
PYNT-45	Yes	Perovskite	High	<2000	-	-	-	-	Low	325	325
BSPT-58	Yes	Perovskite	High	<3100	-	-	Med 10^{14}	-	Low	410	410
Perovskite(s)	Yes	Perovskite	High	-	-	-	Low-Med	$0.02-2 \times 10^3$	Low	-	-

Previous data

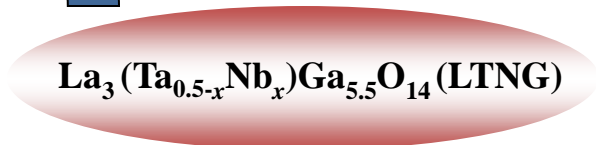
Substitution of octahedral site



La₃Ta_{0.5}Ga_{5.5}O₁₄ crystals



1. Solid solution
2. Detailed piezoelectric properties
3. High temperature property



Feedback

Crystal chemistry

Considering ionic size, valence and structure

Phase identification

Investigation for solid solution range (X-ray diffraction pattern)

Melting behavior

Investigation of melting point and behavior (TG/DTA)

Micro-Pulling-Down Growth

Check of the possibility of melt growth

Czochralski Growth

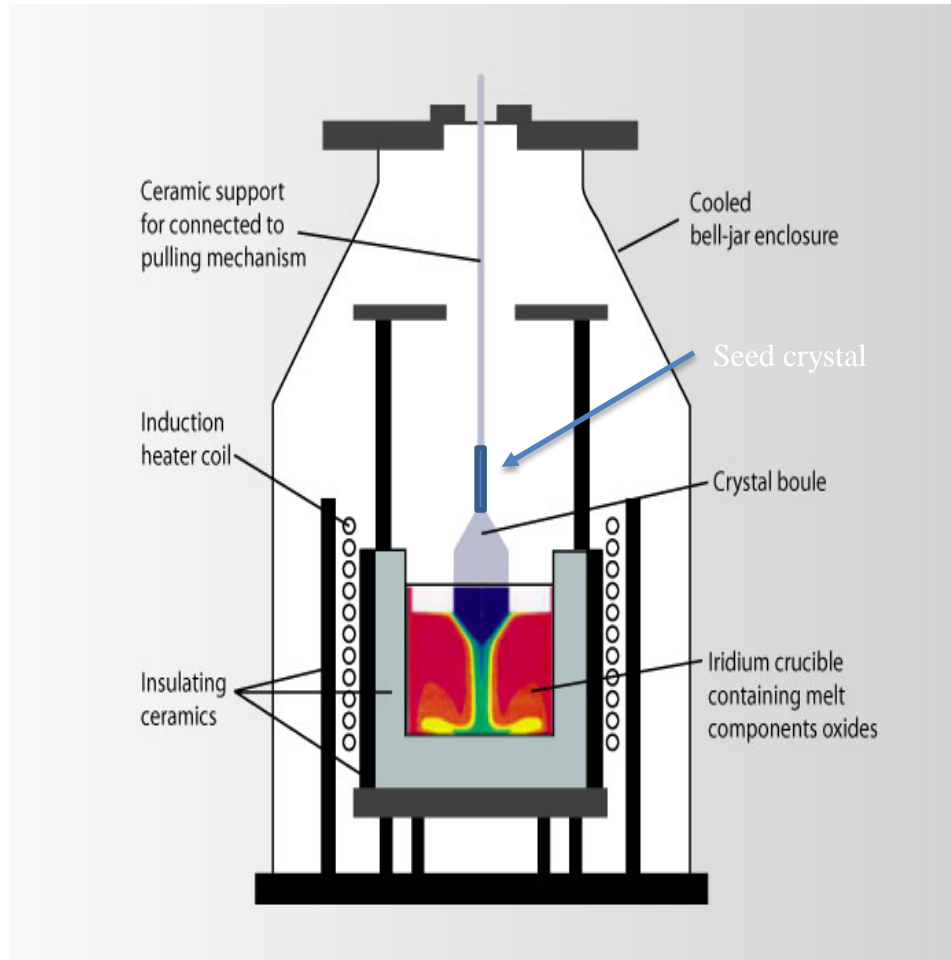
Bulk crystal growth for the high temperature piezoelectric applications

Characterization

**XRD (crystal structure)
Chemical etching
EPMA, AFM,
OM**

Device preparation

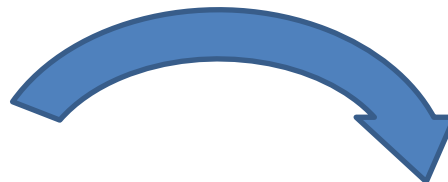
**Piezo-modulus (d)
Electric conductivity
Thermal property**



LGT ingot and wafer development for SAW and BAW applications



LGT
Ingot 2''
Z orientation



**Component
For resonator
(Time Frequency)**
Diameter : 20 mm



High temperature resistant material
For
high temperature measurement sensor

Applications :

- > structural health monitoring
- > Process / operation control

In severe environment :

- > High temperature
- > oxydative atmoshpere...

R&D European project
SAWHOT

Development of a wireless saw sensor for
high temperature resistant and
measurement

