

Excimer Laser Annealing of Piezoelectric Thin Films for MEMs Applications

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Motivation:

The objective of this program is to crystallize pure and doped lead zirconate titanate (PZT) thin films using a pulsed excimer laser for MEMs applications.

The following are the objectives for this work:

- To establish laser processing parameters which enable crystallization of piezoelectric PZT (52/48) thin films on Si wafers below 450 °C.
- To investigate orientation and texture of PZT thin films using template method in laser annealing.
- To study the structural and electrical properties of laser annealed samples as a function of the crystallization parameters.

We anticipate that such low temperature crystallization of ferroelectric thin film layers will facilitate monolithic integration of ferroelectric layers on ROICs with reduced thermal budgets.

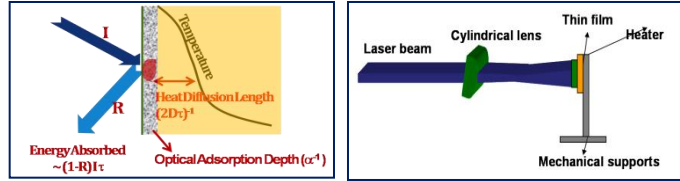
Applications and Benefits:

- Can process multicomponent functional materials at < 250 °C on polymer substrates
- Complete compatibility with existing/future ROIC and CMOS systems
- Minimize development cost and processing time

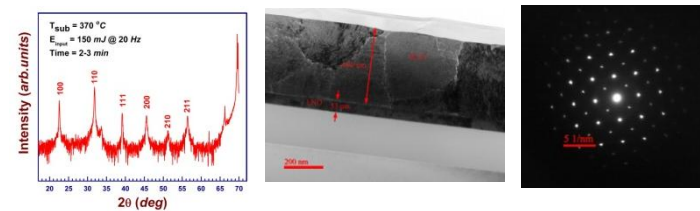
Vision for Project:

- Crystallize piezoelectric and dielectric thin film wafers (4"-6") on silicon substrates below 400 °C for MEMs and capacitor applications
- Theoretical investigation of crystallization kinetics in sub-microsecond time scales in excimer laser annealed ferroelectric thin films
- Structural characterization of laser annealed ferroelectric films
- Extending laser annealing technique to other functional thin films and bulk materials to integrate on flexible/polymer substrates

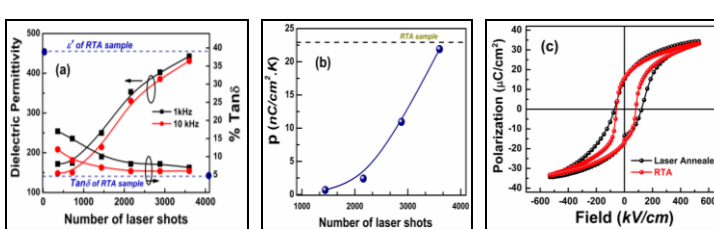
Principle of Pulsed Laser Annealing with Schematic set-up



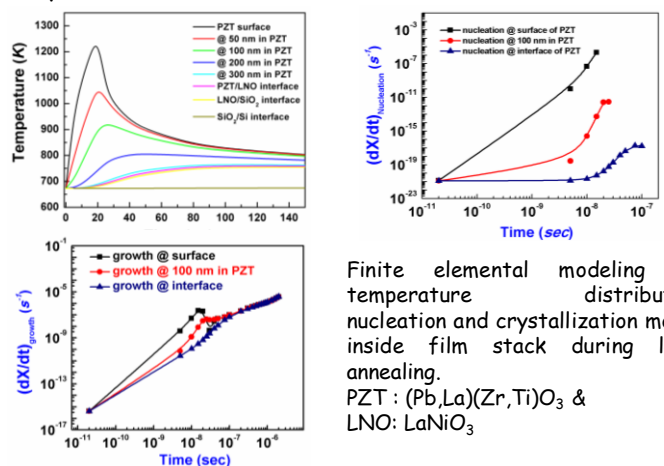
Structural Characterization of Laser Annealed PZT Films



Electrical Properties: (a) Dielectric, (b) Pyroelectric, and (c) Ferroelectric Properties



Crystallization Kinetics in Laser Annealed PZT Films



Finite elemental modeling for temperature distribution, nucleation and crystallization modes inside film stack during laser annealing.
PZT : (Pb,La)(Zr,Ti)O₃ &
LNO: LaNiO₃

Vision: Applications for Laser Annealing of Thin Films



Ferroelectric Thin-Film based IR Detector Pixel Arrays;
Flexible electronics, RF MEMs etc