Printing piezoelectric materials for energy harvesting applications

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Light

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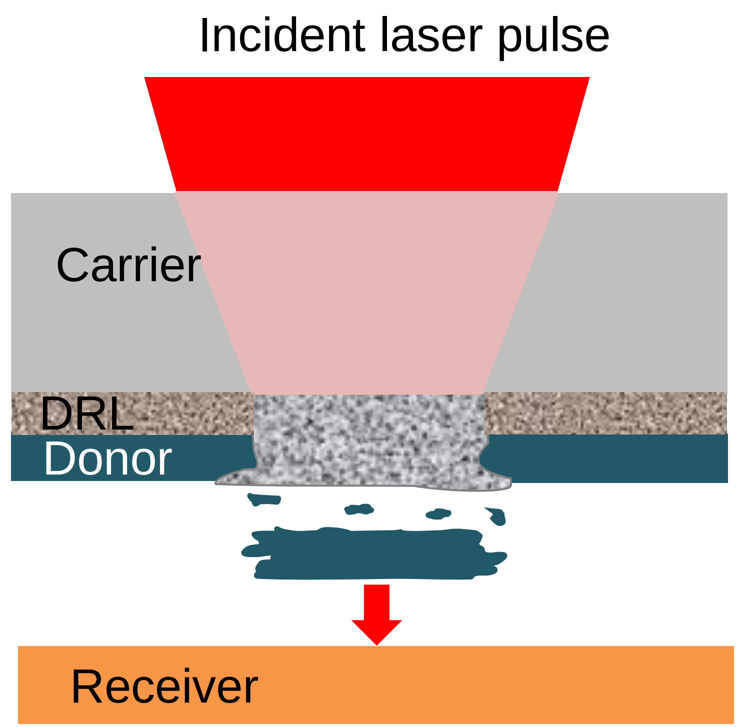
Outline

- ❑ Introduction
- ❑ fs-DRL-LIFT printing and characterization of PZT
- ❑ Printing large area pellets using beam shaper
- ❑ ns-DRL-LIFT printing and characterization of PZT
- ❑ Conclusions and Outlook

Introduction

- Piezoelctric energy harvesters as alternative sources of energy
- PZT the most effeicient piezoelectric material
- Screen printing is not suitable for printing micron sized features, on pre-mettalized and on flexible substrates



Introduction

fs-DRL-LIFT printing characterization of PZT

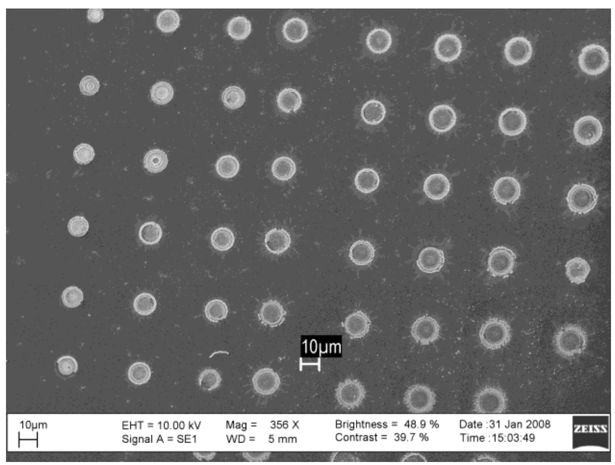
Printing large area pellets using beam shaper

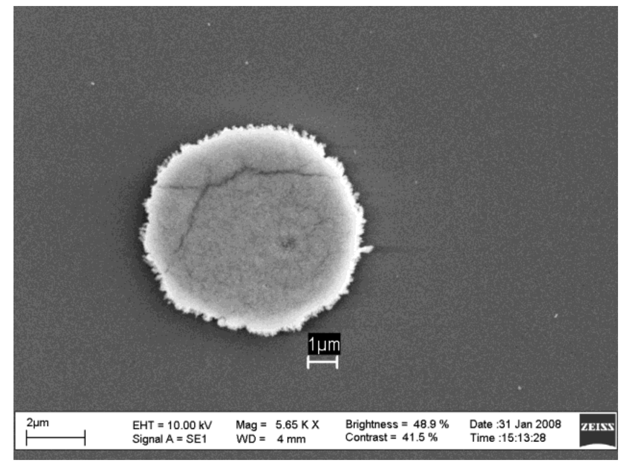
ns-DRL-LIFT printing and charaterization of PZT

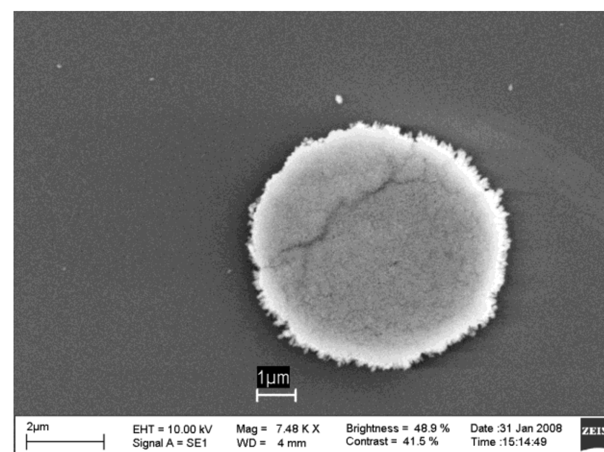
Conclusions and Outlook

Printing of PZT using fs-DRL-LIFT

- PZT film (150 nm) deposited using PLD on top of triazene polymer (TP) (200 nm)
- Ti:sapph (800 nm, 150 fs)
- Fluence ~ 360 mJ/cm^2







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Charaterization using PFM

- Baking at 100^0C at ramp rate of $2^0/min$ for a dwell time of 1 hour
- Voltages of + 100 and – 100 were applied for 20 s each

No signal recorded!!!

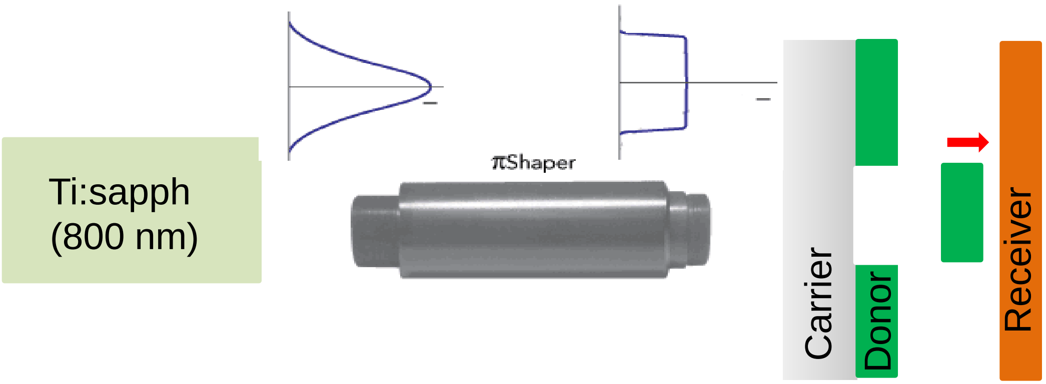
Possible reasons for no mechanical response:

- Small dimensional change to be detected
- Absence of any internal net polarization

Thicker deposits and in-situ heating and poling

Printing large area deposits using fs-DRL-LIFT

- mm^2 size deposits for in-situ heating and poling
- Refractive beam shaper (πshaper) for converting Gaussian to flat-top beam



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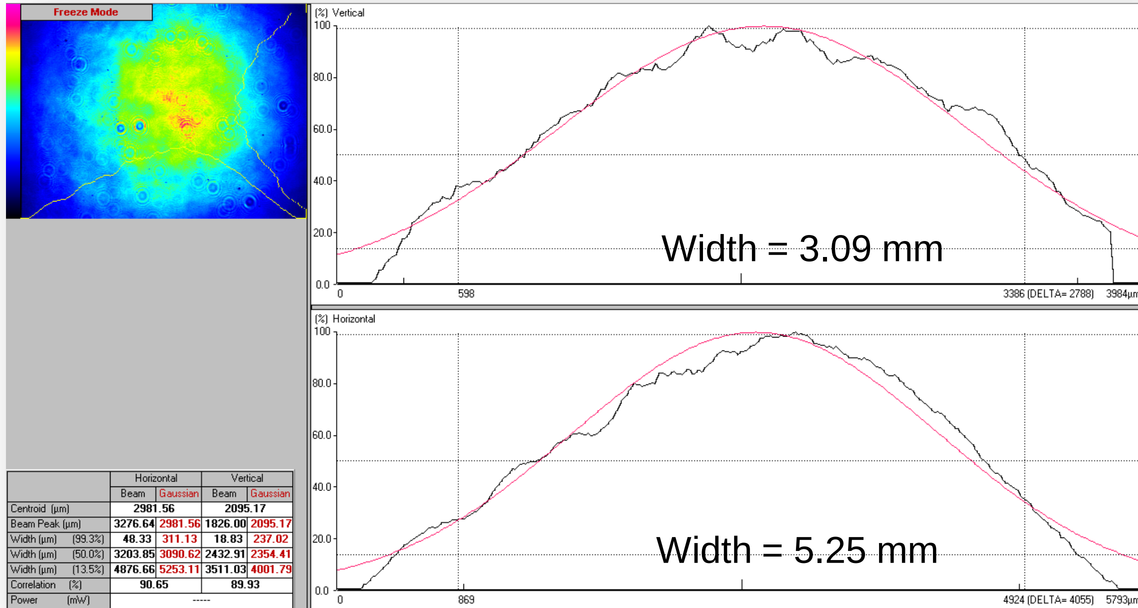
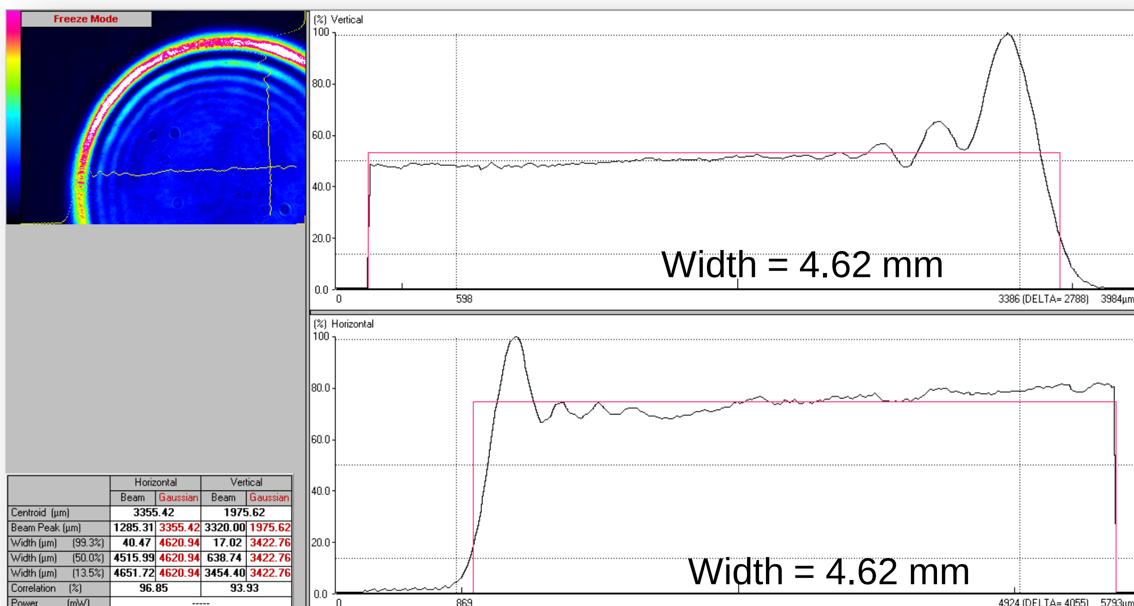
Input beam profile



Output beam profile at 45 cm



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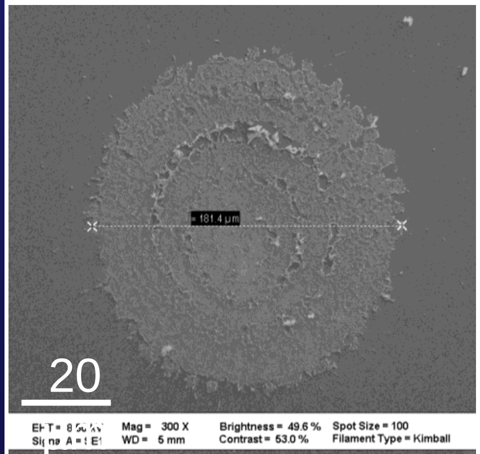
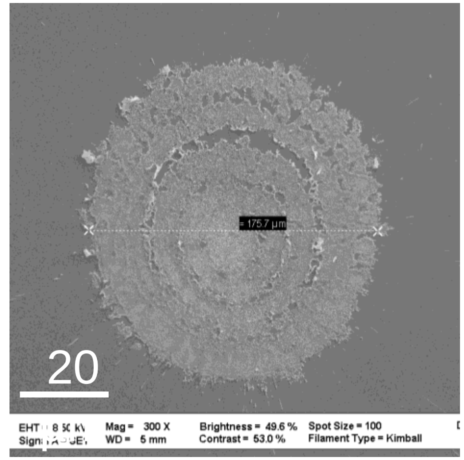
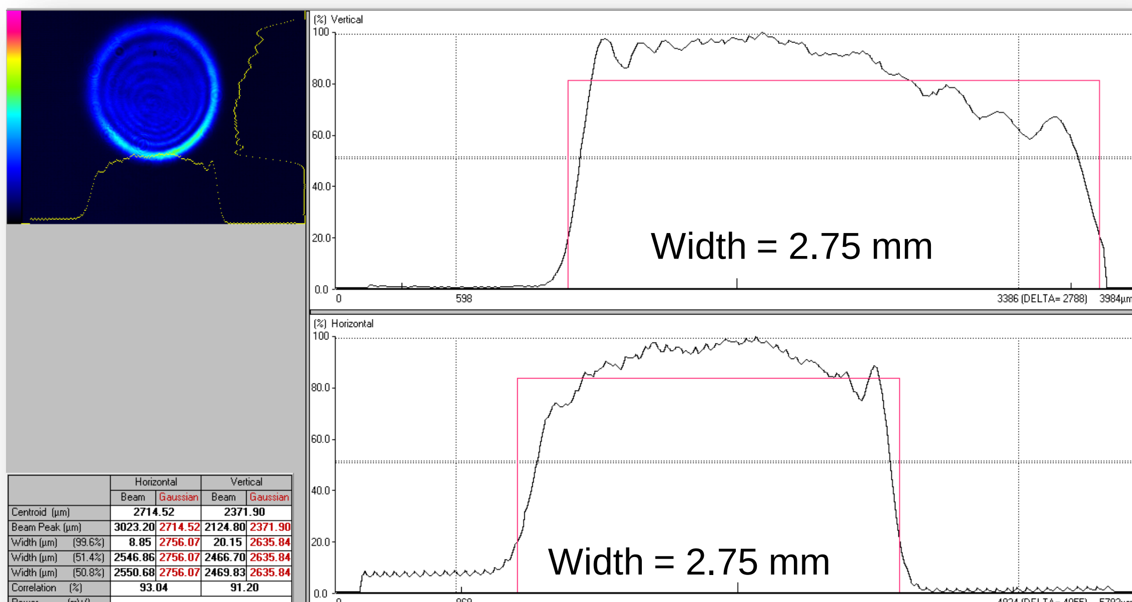
Deposits printed using pi-shaper





- Ti donor film (~ 150 nm thick)
- Ring patterns visible in the deposits

Intensity profile of the output beam from pi-shaper at ~ 150 cm



	Horizontal		Vertical	
	Beam	Gaussian	Beam	Gaussian
Centroid (µm)	2714.52		2371.90	
Beam Peak (µm)	3023.20	2714.52	2124.80	2371.90
Width (µm) (99.6%)	8.85	2756.07	20.15	2635.84
Width (µm) (51.4%)	2546.86	2756.07	2466.70	2635.84
Width (µm) (50.8%)	2550.68	2756.07	2469.83	2635.84
Correlation (%)	93.04		91.20	
Power (mW)	-----			

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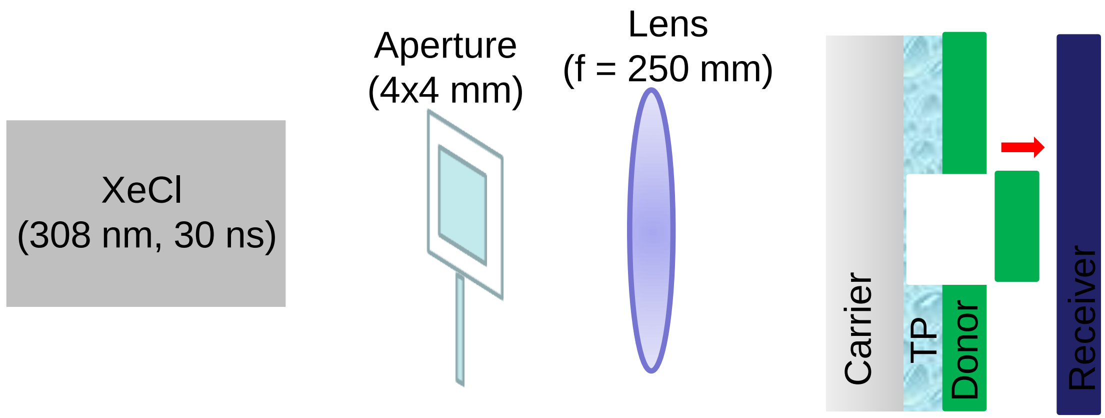
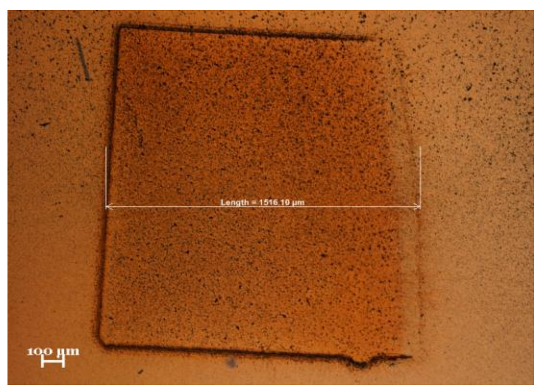
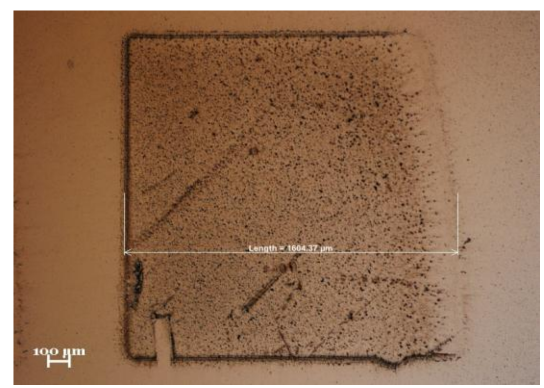
Printing mm^2 pads of PZT using ns-DRL-LIFT



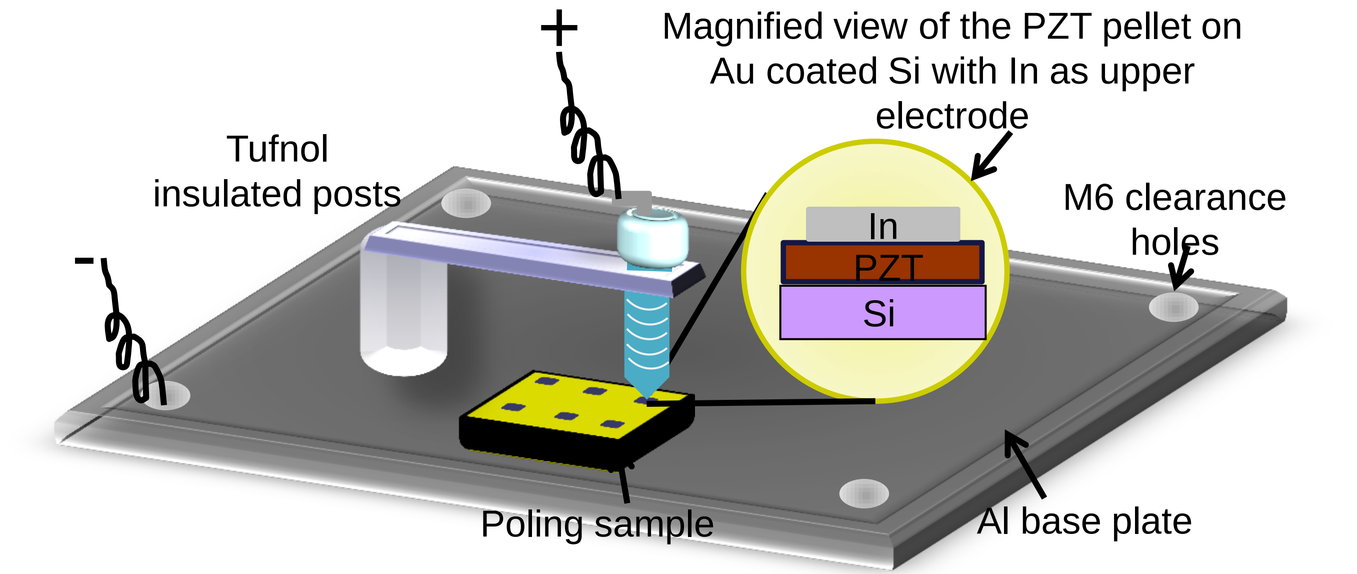


150 nm thick; 380 mJ/cm^2



1 µm thick; 1.5 J/cm^2

Characterization employing in-situ heating and poling




Commercial piezometer (PM35)

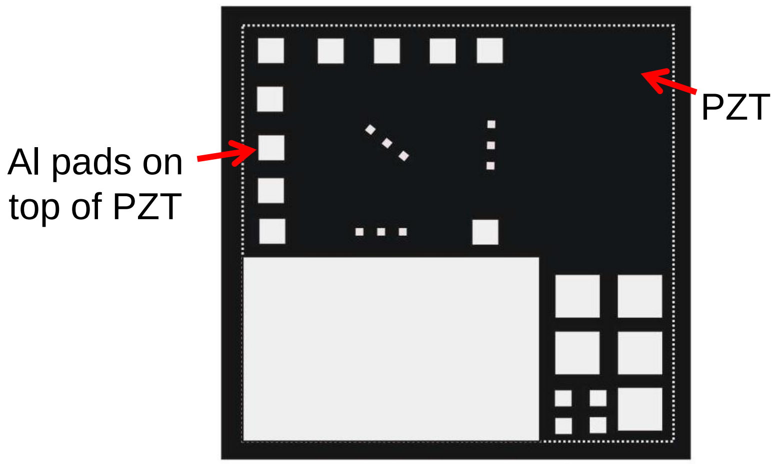
Longitudinal d_{33} piezoelectric coefficients ~ 20 pC/N were recorded for 1 µm thick pellets

Problems

- ➢ Difficult to place the metal foil on top of the deposits - not an optimum method
- ➢ Pellets get damaged during measurements leading to short-circuiting
- ➢ Difficult to repeat the measurements

Printing multilayers

- ✓ Metal (Al) pads underneath PZT films
- ✓ Metal fim serves dual purpose- acts as a DRL and upper electrode



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Conclusions and Outlook

- PZT pellets were printed using the fs/ns-DRL-LIFT techniques
- Post printing characterzation using PFM and in-situ heating and poling
- Longitudinal d_{33} piezoelectric ~ 20 pC/N were measured
- Printing of multilayers (PZT + metal) can be employed to avoid damage to the deposits during measurements

Thanks

E-LIFT

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EMPA Materials Science & Technology