ADAPTED TRANSFER PRINTING TECHNIQUE FOR FLEXIBLE FILM BULK ACOUSTIC RESONATOR FABRICATION

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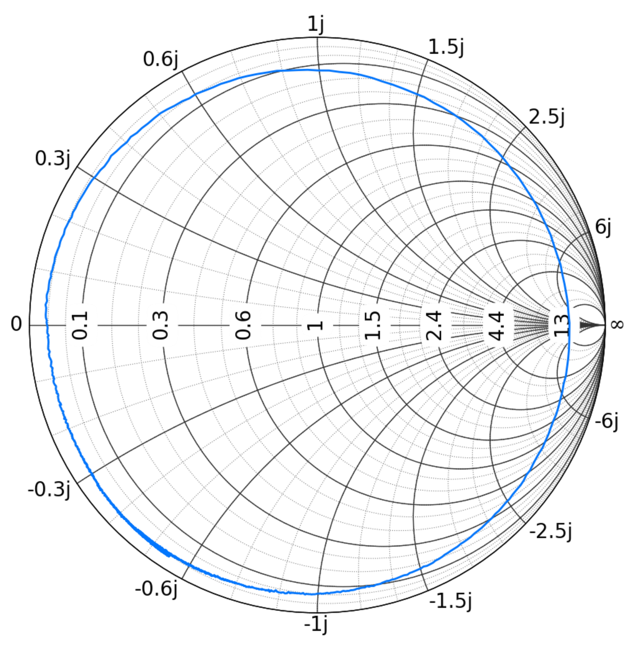
INTRODUCTION

- FBAR(Film Bulk Acoustic Resonator) played an important role in wireless **communication** system, it is also capable of **sensing** small mass based on the theory of resonant frequency shift.
- **Transfer printing** [1] can be used to selectively retrieve inorganic material from its native substrate and deterministic assembly them on a flexible substrate.
- Chen et al [2] fabricated FBAR directly on a polyimide substrate. However, acoustic waves dissipate into the substrate without an air cavity.
- **We developed an adapted transfer printing technique to fabricate air-cavity based FBARs on flexible PET substrates with a reasonable performance.**

PERFORMANCE



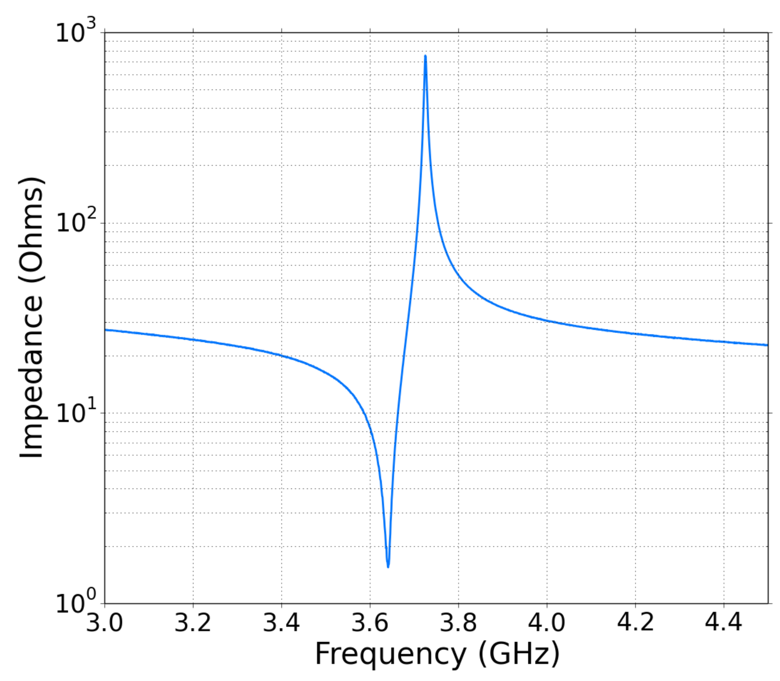
Quality factor at parallel resonant frequency

$$Q_p \sim 691$$

Smith circle of our device: the large circle indicates a good quality factor of FBAR devices.

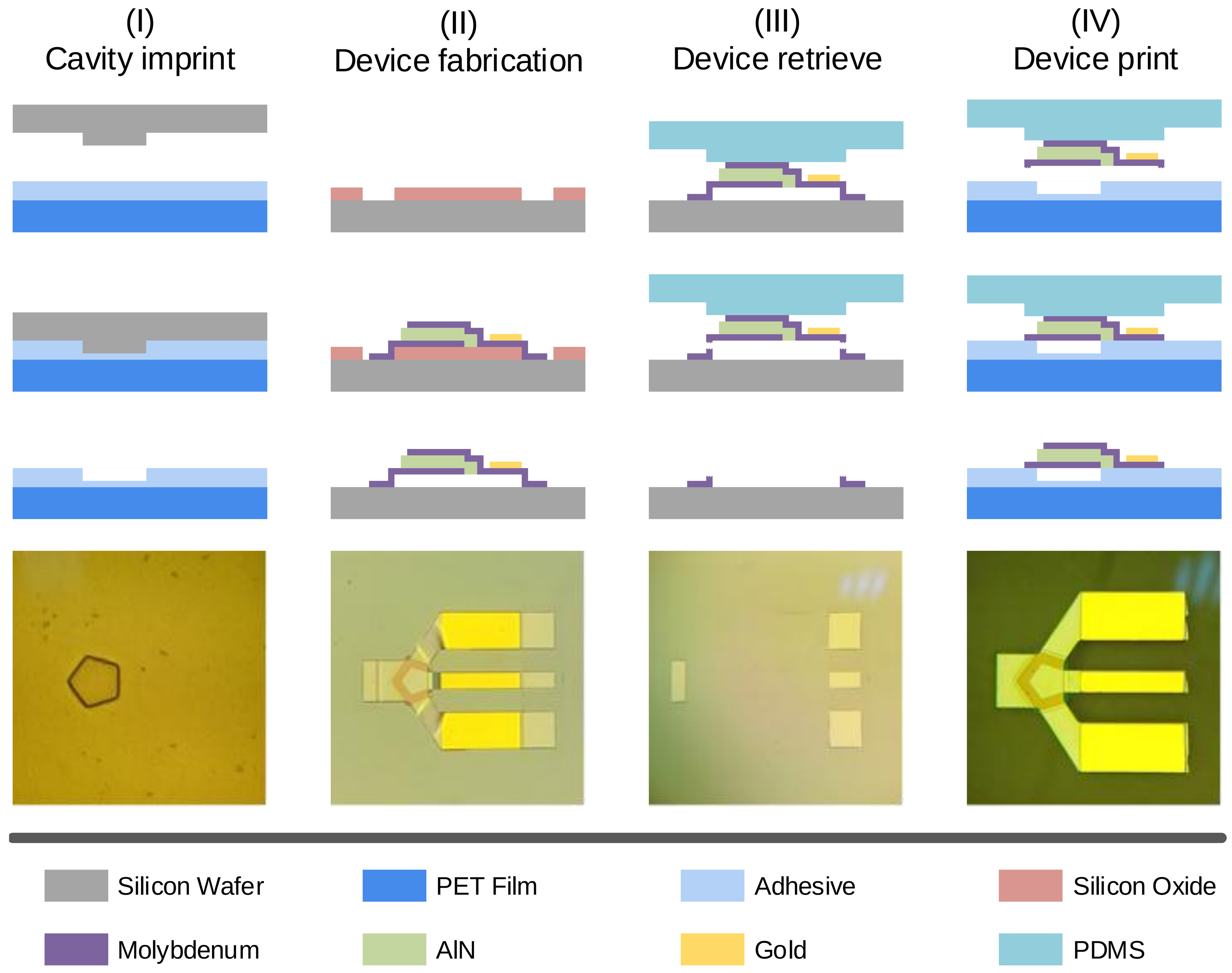
Piezoelectric coupling coefficient

$$K_t^2 \sim 5.6\%$$



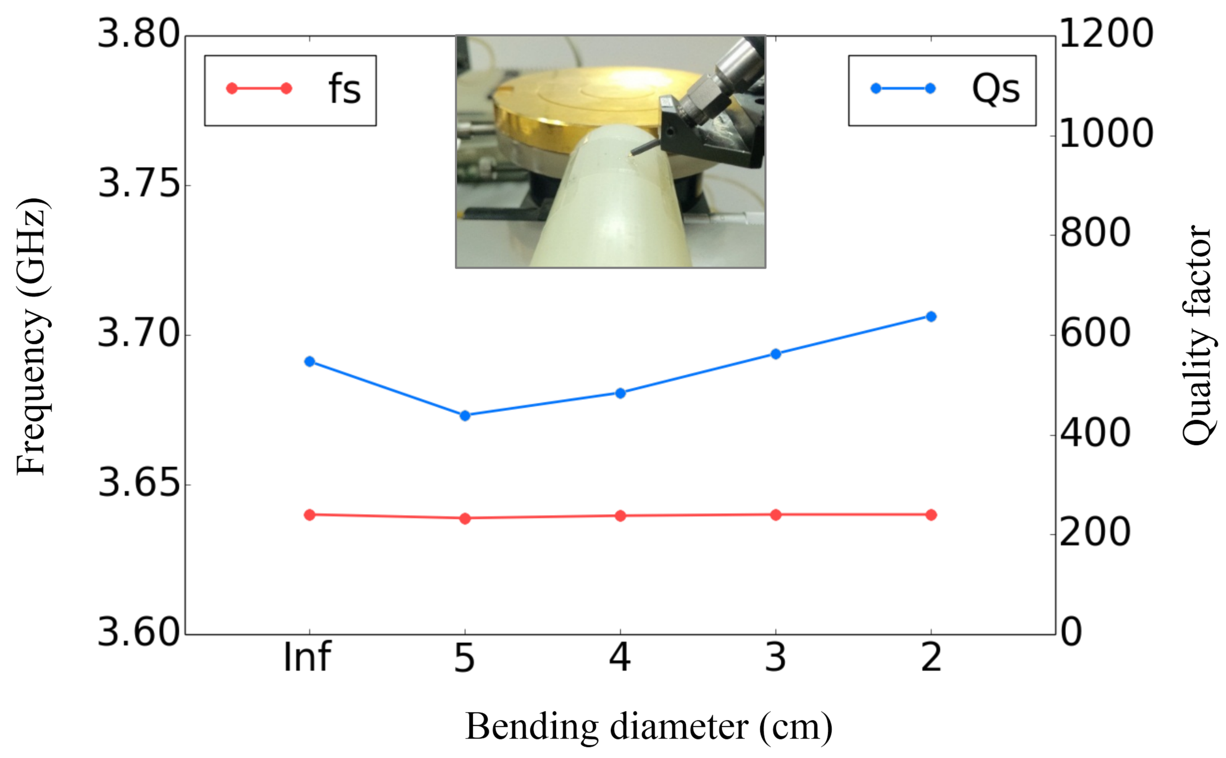
Frequency - Impedance curve: K_t^2 ~ 5.6%, indicating a highly c-axis aligned aluminum nitride crystal structure.

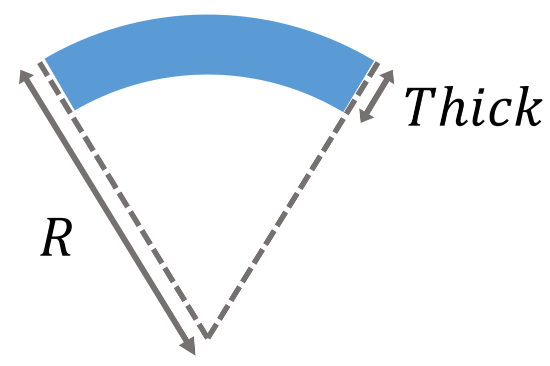
FABRICATION



I. Air cavity was imprinted on a PET substrate with a thin adhesive layer coated on top.
II. FBAR device was first fabricated on a silicon wafer. After release, device was tethered by several anchors to retain its position.
III. Device was retrieved from the silicon wafer.
IV. Device was transfer printed on top of the cavity of PET substrate.

FLEXIBILITY





$$\varepsilon_{max} = \frac{Thick_{sub}/2}{R_{bend}}$$

- Our device can be adhered to a cylinder of 2 cm diameter without device failure, which corresponds to a strain of 0.6%.
- Series resonant frequency f_s remained unaffected during bending.
- Quality factor Q_s fluctuates greatly because of the local deformation of the electrode under probe touch, which then resulted in unpredictable electrical losses under high frequencies.

REFERENCE

[1] Carlson, A. M. Bowen, Y. Huang, R. G. Nuzzo, and J. A. Rogers, "Transfer printing techniques for materials assembly and micro/nanodevice fabrication," *Adv. Mater.*, 24, 5284-5318, 2012.
[2] G. Chen, X. Zhao, X. Wang, H. Jin, S. Li, S. Dong, a. J. Flewitt, W. I. Milne, and J. K. Luo, "Film bulk acoustic resonators integrated on arbitrary substrates using a polymer support layer," Sci. Rep., 5, 9510, 2015.

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MORE INFO

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