SUPPORTING INFORMATION

Unleashing the piezoelectric potential of PVDF: a study on phase transformation from gamma (γ) to beta (β) phase through thermal contact poling

Alban MORALI*[a], Arijit MANDAL[a], Maksim SKOROBOGATIY[b] and Sampada BODKHE*[a]

[a] *Department of Mechanical Engineering, Centre for Applied Research on Polymers and Composites (CREPEC), Polytechnique Montréal, Montréal, QC H3T 1J4, Canada*

[b] *Department of Engineering Physics, Polytechnique Montréal, Montréal, QC H3T 1J4, Canada*

*__Corresponding author:__ sampada.bodkhe@polymtl.ca

Sample	$F_{\beta\gamma}$ (%)	$\Delta H_{\gamma'}$	F_{β} (%)
	Unpoled samples		
N°10	74	0.0789	N/A
	Inverse poled air side		
N°11 d	92	0.0704	25
N°11 e	92	0.0531	45
N°11 f	90	0.0678	32
N°12 d	92	0.0792	43
N°12 e	92	0.0544	56
N°12 f	93	0.0761	46
N°13 d	88	0.0892	21
N°13 e	92	0.0810	39
N°13 f	92	0.0803	34
	Inverse poled glass side		
N°11 a	88	0.1250	N/A
N°11 b	89	0.1141	N/A
N°11 c	88	0.1242	N/A
N°12 a	80	0.1196	N/A
N°12 b	81	0.1114	N/A
N°12 c	83	0.1157	N/A
N°13 a	82	0.1166	N/A
N°13 b	81	0.1195	N/A
N°13 c	82	0.1193	N/A

Fig. S1: Spatially resolved measurements of $F_{\beta\gamma}$, $\Delta H_{\gamma'}$ and F_{β}. Sample nomenclature for different films is denoted with by numbers (10-13) and scan locations are labelled with by letters (a-f). The data is arranged from the worst values of $F_{\beta\gamma}$ in red to the better one in green.

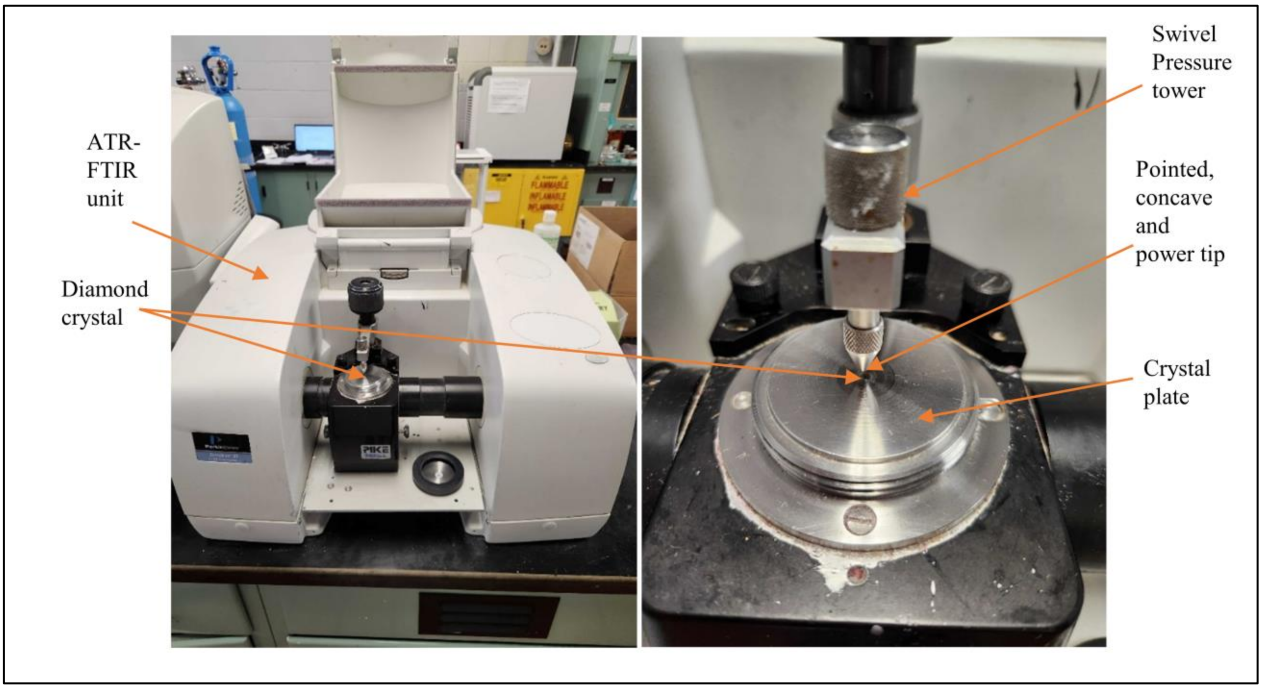

Fig. S2: ATR-FTIR used for the measurements

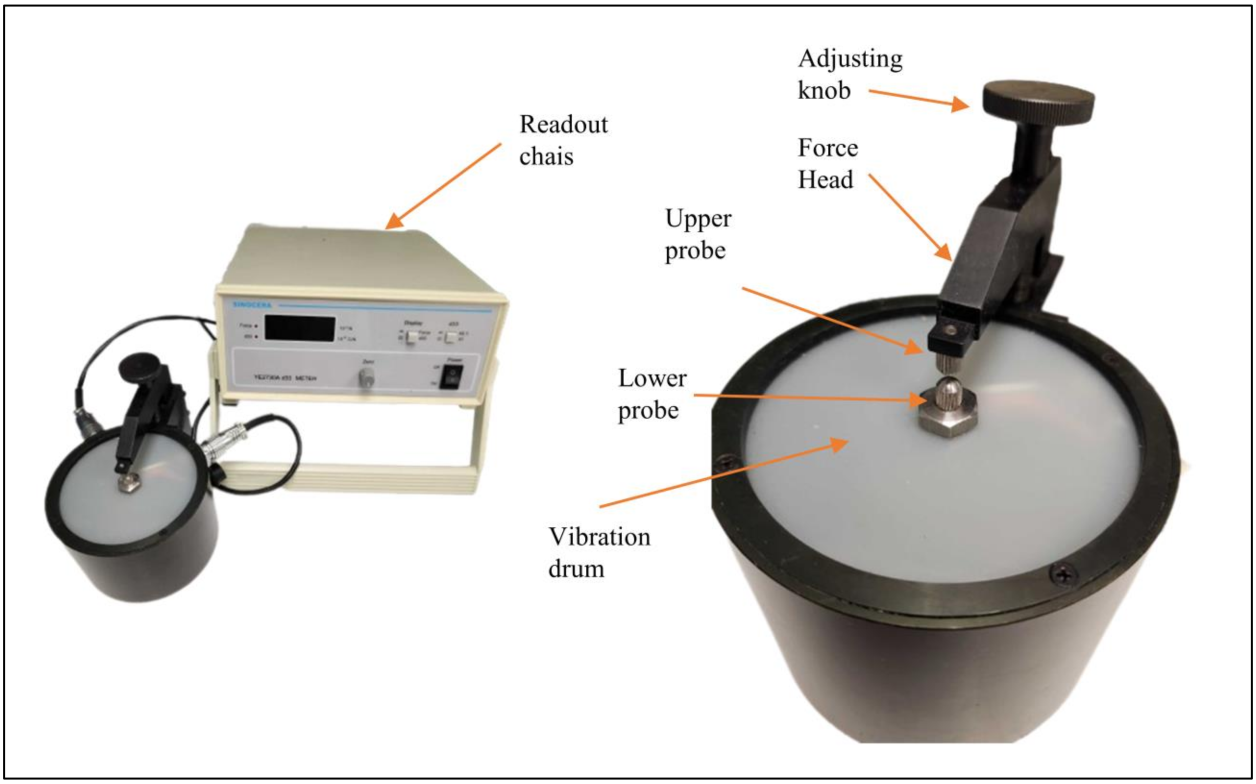

Fig. S3: d_{33}-meter with an enlarged view of the measurement device.

The piezoelectric mechanism is a property exhibited by certain materials, where mechanical stress or deformation induces an electrical charge within the material, and conversely, an applied electrical field can cause mechanical deformation. This phenomenon is primarily observed in specific crystals, ceramics, and biological materials. The underlying principle is the asymmetric arrangement of atoms in the material's crystal lattice, which leads to a net polarization when subjected to mechanical stress, generating an electric field as illustrated Fig.S4 [1]. Similarly, when an electric field is applied, it causes a shift in the atomic arrangement, resulting in mechanical deformation. This unique mechanism has found extensive applications in various fields including sensors, transducers, and energy harvesting devices, leveraging the direct and inverse piezoelectric effects to convert energy between mechanical and electrical forms.

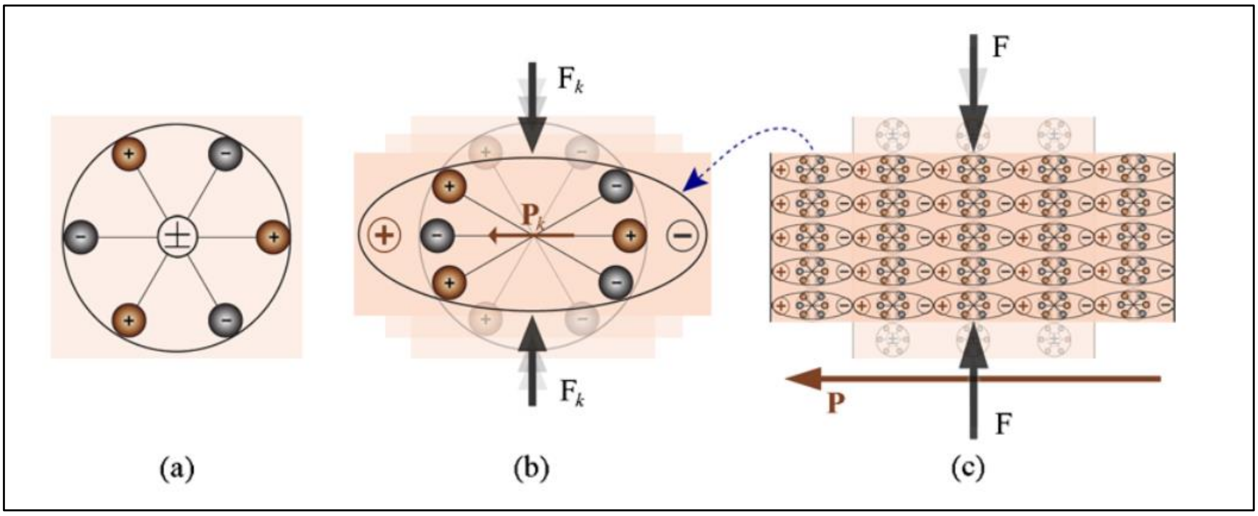

Fig. S4: Piezoelectric effect explained with a simple molecular model: (a) An unperturbed molecule with no piezoelectric polarization (though prior electric polarization may exist); (b) The molecule subjected to an external force (F_k), resulting in to polarization (P_k) as indicated; (c) The polarizing effect on the surface when piezoelectric material is subjected to an external force. Adapted from [1].

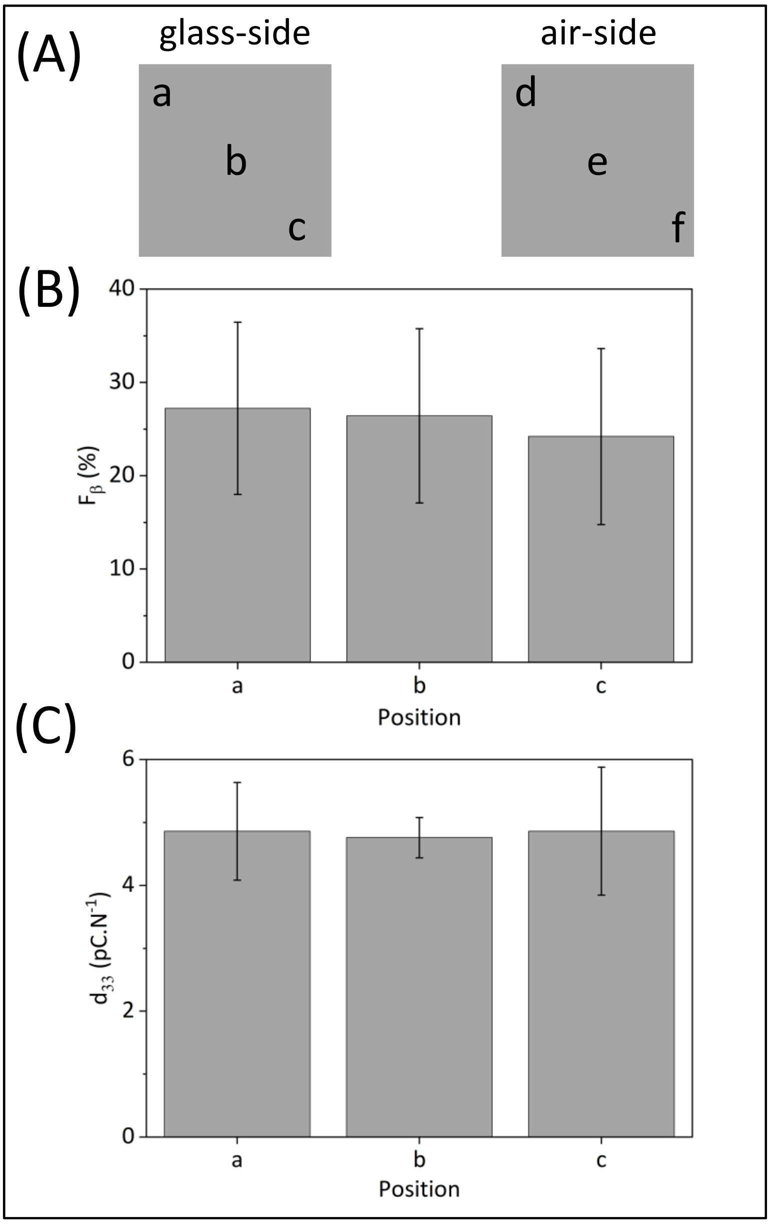

Fig. S5: (A) Schematic of the measurement's positions on the samples area. Bar chart of average F_{β} (B) and d_{33}(C) values of 5 samples depending on the position (a-c).

References:

[1] M. V. R.S. Dahiya, "Fundamentals of Piezoelectricity," 2013.