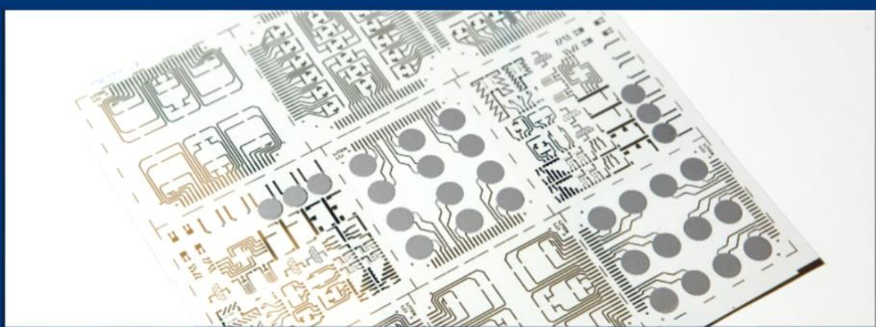
PIEZOTECH®
BY ARKEMA

TDS PIEZOTECH® FC INK P

For Printed Organic Electronics,
Smart Textiles and Plastronics



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I. Technical Data

Technology	**Screen Printing**	**Thickness range (µm)**	1 - 20
For	Piezotech® FCInk P	**Viscosity (mPa.s)**	23000
Curie Temp. (°C)	135	**Base Solvent (s)**	Triethylphosphate
Melting Temp. (°C)	150	**Typical dry content value (%)**	18
Annealing Temp. (°C)	135	**Boiling Point (°C)**	215

II. Printing Data

Layers between 1 µm and 20 µm can be deposited by screen printing technique.

Typical process used for a screen-printed 2 µm thick layer

<u>Materials</u>
Polymer: Piezotech® FC Ink P
Substrate: PEN 125µm thick – expl: Teonex Q65HA from Dupont
Electrodes:
Silver ink - expl: HPS021LV from Novacentrix
PEDOT-PSS ink - expl: Clevios SV 4 from Heraeus

<u>Screen parameters - polymer layer</u>
Screen cloth: Polyester
Wire diameter: 40 µm
Mesh count per cm: 100

<u>Process parameters</u>
Blade speed: 200 mm/s
Blade pressure: 40 N
Off-contact substrate-screen distance: 1.6 mm

<u>Screen parameters – conductive layer</u>
Screen cloth: Stainless steel
Wire diameter: 20 µm
Mesh count per cm: 300

III. Post-printing Treatment

III.1 Annealing

After deposition, the layer has to be annealed above the Curie Transition Temperature to increase crystallinity and performances.

<u>For the conductive layer</u>
1 - Hot plate / 60 °C -> 3 mn (solvent evaporation step)
2 - Infrared oven / 135 °C -> 5 mn (annealing step)

For the polymer layer
Infrared oven 135 °C -> 15 mn

Other possibility
Vacuum for solvent evaporation and Conventional oven for the annealing step.

III.2 Poling

In order to acquire its piezoelectric properties, the ferroelectric layer has to be poled by applying a voltage above the coercive field.

Typical Process
An electric field is applied according to the following cycle:
Voltage ramp: 0 V.µm^{-1} to $+E_{max}$, $+E_{max}$ to $-E_{max}$, $-E_{max}$ to 0 V.µm^{-1}
Frequency: 0.05 Hz (higher is possible)
Number of cycles to reach 100 V.µm^{-1}: 15
Signal wave form: Sinusoidal

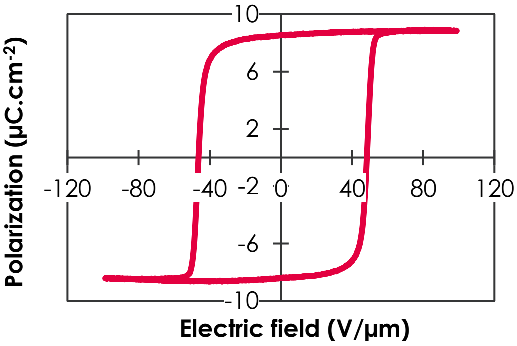


Figure 1. Typical polarization curve obtained with the printed Piezotech® FC 25 ink P

Poling can also be carried out by applying a constant electric field (after a progressive rise) for a few minutes while heating the sample

IV. Typical properties for a poled film

Relative dielectric permittivity, ε_r (1 kHz)	11	**Remnant polarization P_r (mC.m^{-2})**	70
Piezoelectric coefficient d_{33} (pC/N or pm/V)	-26	**Coercive field (V/µm)**	45
Pyro-electric coefficient, ρ, (µC/m².K)	-22	**Dielectric strength (V/µm)**	400

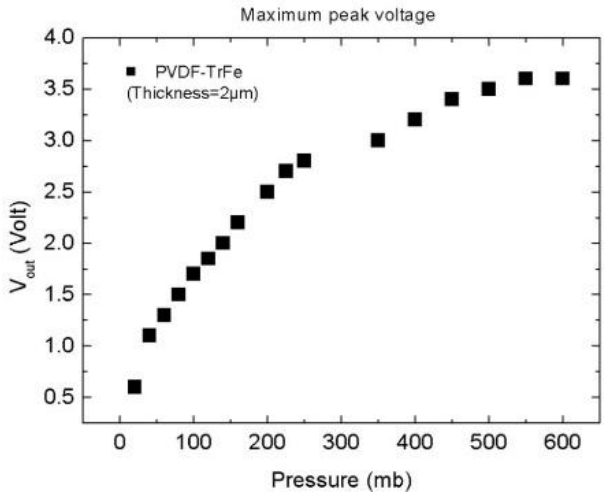


Figure 2. Typical electrical response for a Piezotech® FC 25 ink P printed sensor. The voltage is obtained by applying a gas flow.

V. Design Concept

Polarization connection
The thin film polarization is achieved by using contact probes. In order to prevent damages to the electrodes between the probes and the metallization, reinforced electrode surfaces can be printed

Polymer / electrodes surface ratios
The surface of the printed polymer has to be larger than the electrode surface in order to avoid electrical breakdown between upper and bottom electrodes

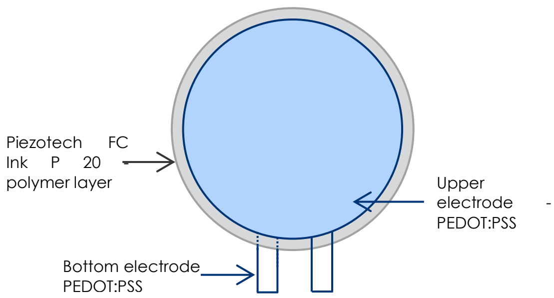


Figure 3. Example of the screen printed Piezotech® FC Ink P layer design

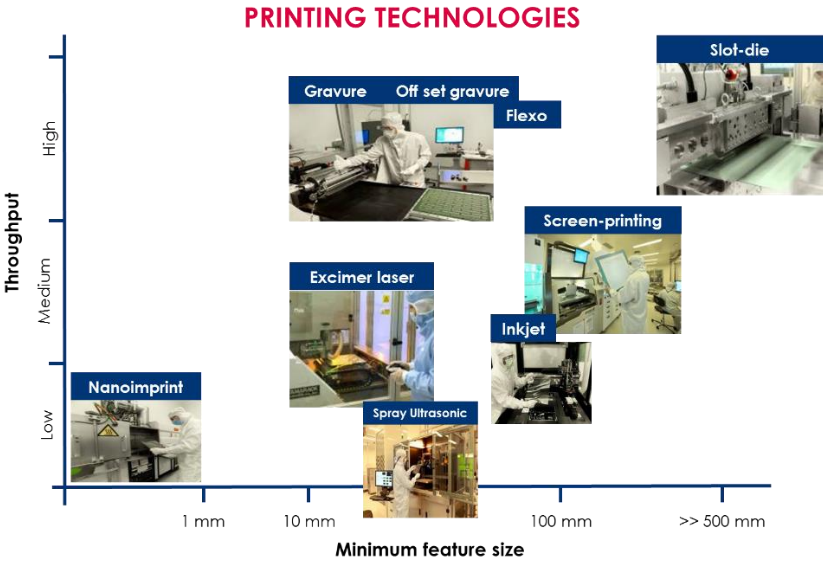
VI. Safety and Storage

Please refer to the safety datasheet

Annex 1. Piezotech® FC and RT Ink Range

Grade	Technology	Viscosity (mPa.s)	Thickness Range (µm)	Typical Dry Content (wt%)	Boiling Point (°C)
Ink I	Ink-jet	16 ±10%	0.05 - 2	0.6	116-120
Ink L	Spin-coating Slot-die	250 ±10%	0.1 - 2	7	128-132
Ink H	Spin-coating Solvent-casting	2300 ±10%	Spin-coat: 5 – 20 Solvent-cast: 2 - 80	20	78-82
Ink P	Screen-printing	23000 ±10%	1 - 20	17.5	213-217

Specific ink formulations could be developed to fit your printing process. Do not hesitate to ask us.



Typical Properties

Ink Name	Piezotech® FC Ink	Piezotech® RT Ink
	Pyro/Piezoelectric	**Electrostrictive and High-k**
Base Polymer	Piezotech® FC 20	Piezotech® RT-TS
Melting Temp. range(°C)	148 - 152	115 - 130
Annealing Temp. (°C)	135 - 140	105 - 120
Curie Temp. range(°C)	130 - 140	-

Annex 2. Possible Solvents for Piezotech® Polymers

Indicative list of solvents that can be used to dissolve & formulate Piezotech FC® and Piezotech® RT polymers.

	Boiling Point (°C)	Flash Point (°C)
Acetone	56	-18
Tetrahydrofuran	65	-17
Methyl EThyl Ketone	80	-6
Methyl Isobutyl Ketone	118	23
Glycol Ethers	118	40
Glycol Ether Esters	120	30
N-Butyl Acetate	135	24
Dimethyl formamide	153	67
Cyclohexanone	157	54
Dimethyl acetamide	166	70
Diaceton Alcool	167	61
Diisobutyl Ketone	169	49
Tetramethyl urea	177	65
Ethyl Aceto Acetate	180	84
Dimethyl Sulfoxide	189	35
Trimethyl phosphate	195	107
N-Methyl-2-Pyrrolidone	202	95
Butyrolactone	204	98
Isophorone	215	96
Triethyl phosphate	215	116
Carbitol Acetate	217	110
Propylene Carbonate	242	132
Glyceryl triacetate	258	146
Dimethyl Phtalate	258	149