

TDS PIEZOTECH[®] FC INK P

For Printed Organic Electronics,
Smart Textiles and Plastronics

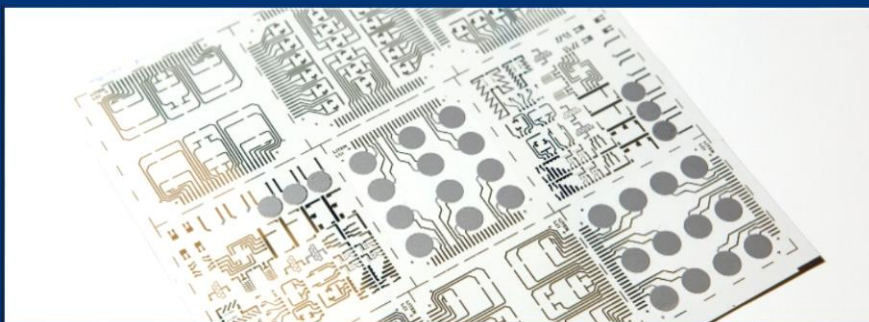
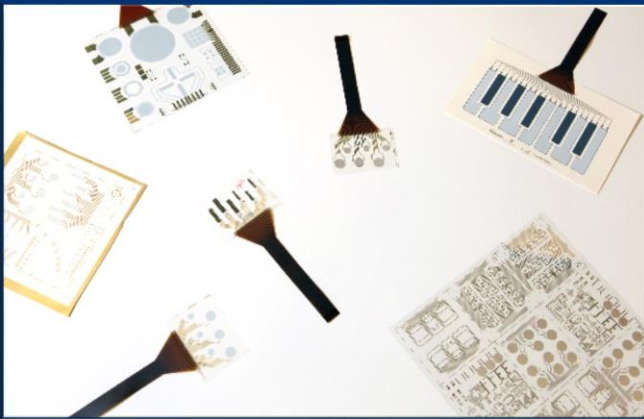


Table of Contents

I. Technical Data	3
II. Printing Data.....	3
III. Post-printing Treatment.....	3
III.1 Annealing	3
III.2 Poling	4
IV. Typical properties for a poled film	4
V. Design Concept	5
VI. Safety and Storage.....	5
Annex 1. Piezotech [®] FC and RT Ink Range.....	6
Annex 2. Possible Solvents for Piezotech [®] Polymers.....	7

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

Materials

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

Screen parameters - polymer layer

Screen cloth: Polyester

Wire diameter: 40 µm

Mesh count per cm: 100

Process parameters

Blade speed: 200 mm/s

Blade pressure: 40 N

Off-contact substrate-screen distance: 1.6 mm

Screen parameters – conductive layer

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.

For the conductive layer

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 $V \cdot \mu m^{-1}$ to $+E_{max}$, $+E_{max}$ to $-E_{max}$, $-E_{max}$ to 0 $V \cdot \mu m^{-1}$

Frequency: 0.05 Hz (higher is possible)

Number of cycles to reach 100 $V \cdot \mu m^{-1}$: 15

Signal wave form: Sinusoidal

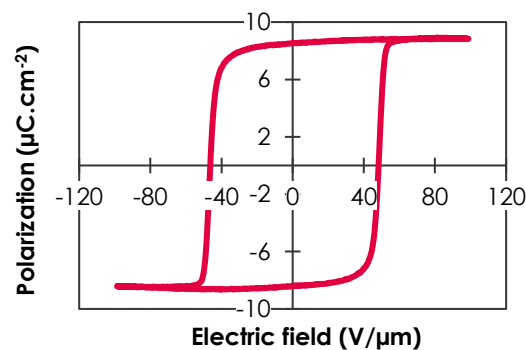


Figure 1. Typical polarization curve obtained with the printed Piezotech® FC 25 ink P

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 ($mC \cdot m^{-2}$)	70
Piezoelectric coefficient d_{33} (pC/N or pm/V)	-26	Coercive field ($V/\mu m$)	45
Pyro-electric coefficient, ρ , ($\mu C/m^2 \cdot K$)	-22	Dielectric strength ($V/\mu m$)	400

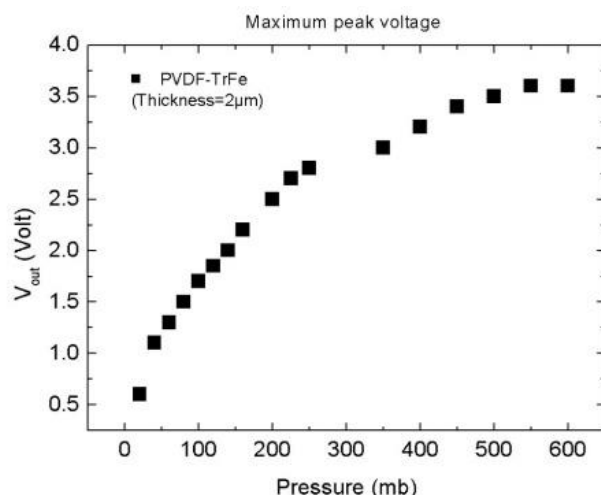


Figure 2. Typical electrical response for a Piezotech[®] FC 25 ink P printed sensor. The voltage is obtained by applying a gas flow.

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

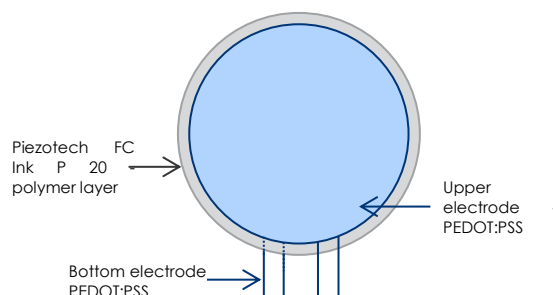


Figure 3. Example of the screen printed Piezotech[®] FC Ink P layer design

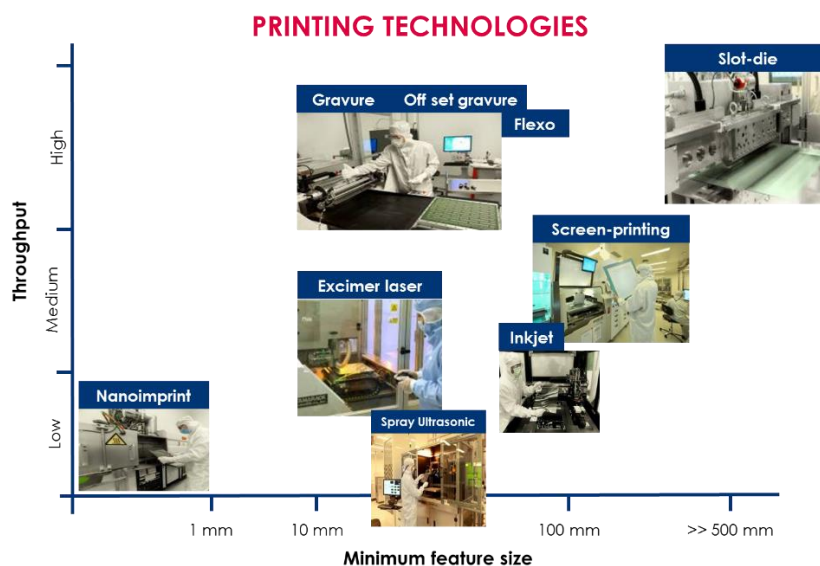
VI. Safety and Storage

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

Contact Information

Piezotech
Arkema-CRRA
Rue Henri Moissan
69496 Pierre-Benite Cedex
FRANCE

Info.piezotech@arkema.com
Phone: +33 4 72 39 87 03
www.piezotech.eu

Disclaimer: The statements, technical information and recommendations contained herein are believed to be accurate as of the date hereof. Since the conditions and methods of use of the product and of the information referred to herein are beyond our control, ARKEMA expressly disclaims any and all liability as to any results obtained or arising from any use of the product or reliance on such information; NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE GOODS DESCRIBED OR THE INFORMATION PROVIDED HEREIN. The information provided herein relates only to the specific product designated and may not be applicable when such product is used in combination with other materials or in any process. The user should thoroughly test any application before commercialization. Nothing contained herein constitutes a license to practice under any patent and it should not be construed as an inducement to infringe any patent and the user is advised to take appropriate steps to be sure that any proposed use of the product will not result in patent infringement. See SDS for Health & Safety Considerations.

Arkema has implemented a Medical Policy regarding the use of Arkema products in Medical Devices applications that are in contact with the body or circulating bodily fluids (<http://www.arkema.com/en/social-responsibility/responsible-product-management/medical-device-policy/index.html>) Arkema has designated Medical grades to be used for such Medical Device applications. Products that have not been designated as Medical grades are not authorized by Arkema for use in Medical Device applications that are in contact with the body or circulating bodily fluids. In addition, Arkema strictly prohibits the use of any Arkema products in Medical Device applications that are implanted in the body or in contact with bodily fluids or tissues for greater than 30 days. The Arkema trademarks and the Arkema name shall not be used in conjunction with customers' medical devices, including without limitation, permanent or temporary implantable devices, and customers shall not represent to anyone else, that Arkema allows, endorses or permits the use of Arkema products in such medical devices.

It is the sole responsibility of the manufacturer of the medical device to determine the suitability (including biocompatibility) of all raw materials, products and components, including any medical grade Arkema products, in order to ensure that the final end-use product is safe for its end use; performs or functions as intended; and complies with all applicable legal and regulatory requirements (FDA or other national drug agencies) It is the sole responsibility of the manufacturer of the medical device to conduct all necessary tests and inspections and to evaluate the medical device under actual end-use requirements and to adequately advise and warn purchasers, users, and/or learned intermediaries (such as physicians) of pertinent risks and fulfill any postmarket surveillance obligations. Any decision regarding the appropriateness of a particular Arkema material in a particular medical device should be based on the judgment of the manufacturer, seller, the competent authority, and the treating physician.