Thickfilm Technology for stretchable circuit.

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Groupe CCI EUROLAM

Summary

- CCI/CTS and the electronics industry
- Thick film technology,
  - Basics
  - Types of pastes
- Printed electronic for medical application
  - Biosensors
  - Wearable, clothes application
  - Medical skin electrode and patches

CTS and CCI

A whole range of product for « printed electronics »

Technical support with laboratory for analysis

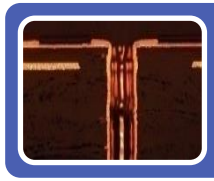
CCI supplier of PCB Materials

PCB substrates

EMC · ARLON ELECTRONIC MATERIALS · ROGERS CORPORATION · DUPONT · KB 建滔積層板控股有限公司 Kingboard Laminates Holdings Ltd.

Electronics grade foils

FURUKAWA ELECTRIC GROUP · UCF · Ohmega Ohmega Technologies, Inc. · CAC



Surface treatment & finishes

DUPONT

Lamination & Drilling

PACOTHANE TECHNOLOGIES · L.C.O.A. · TG GROUP · TADCO

Imaging materials

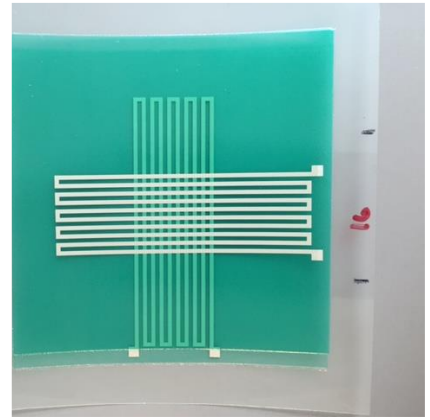
AGFA · HUNTSMAN Enriching lives through innovation · DUPONT · peters Coating Innovations for Electronics

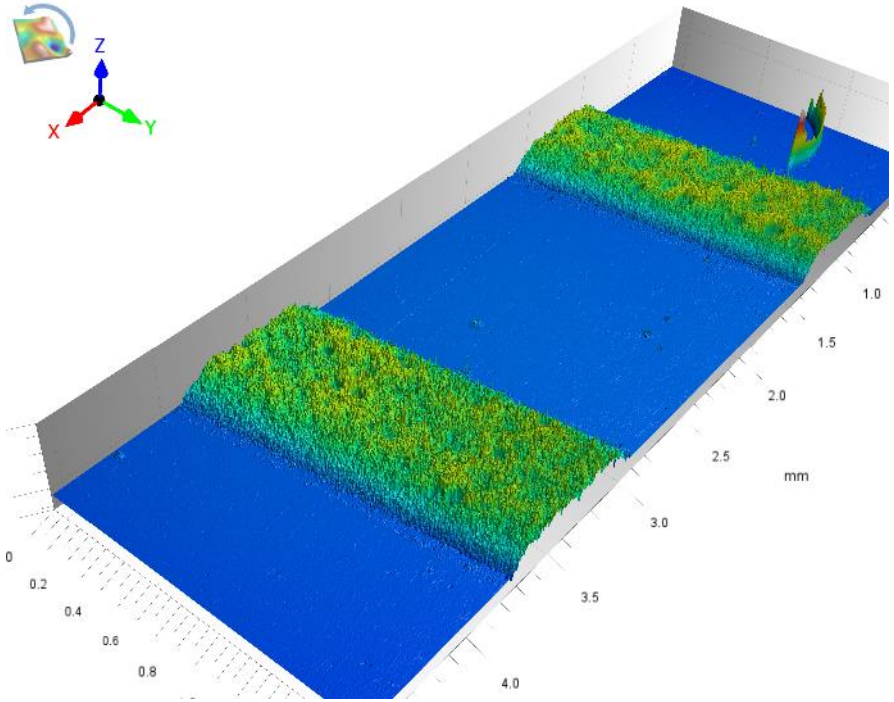
Thickfilm Technology

BASICS

Thickfilm technology

- Dried or sintered thickness of one print between 4µm and 30µm,
- It is thick compare to thin film in nano meter !!





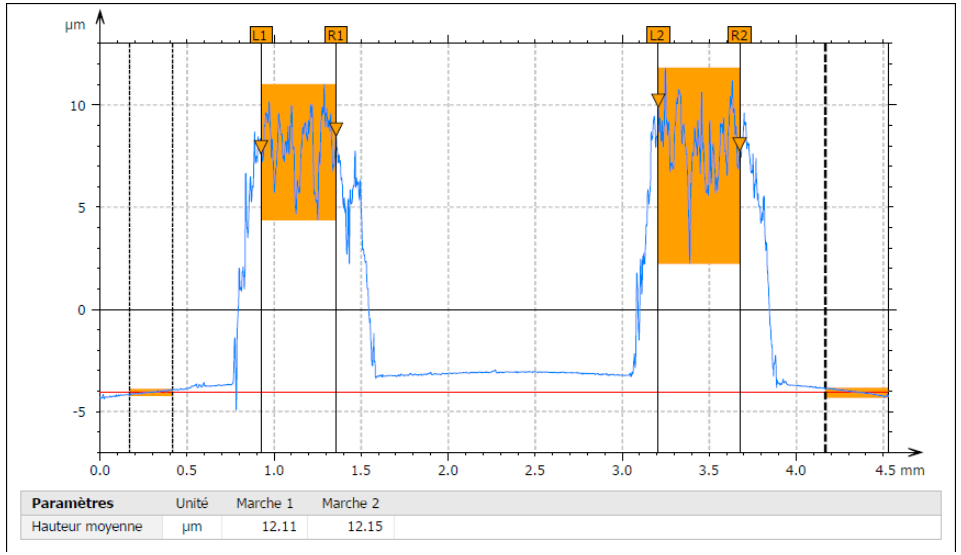
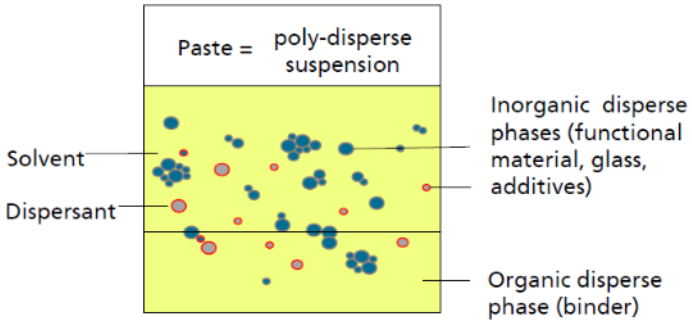
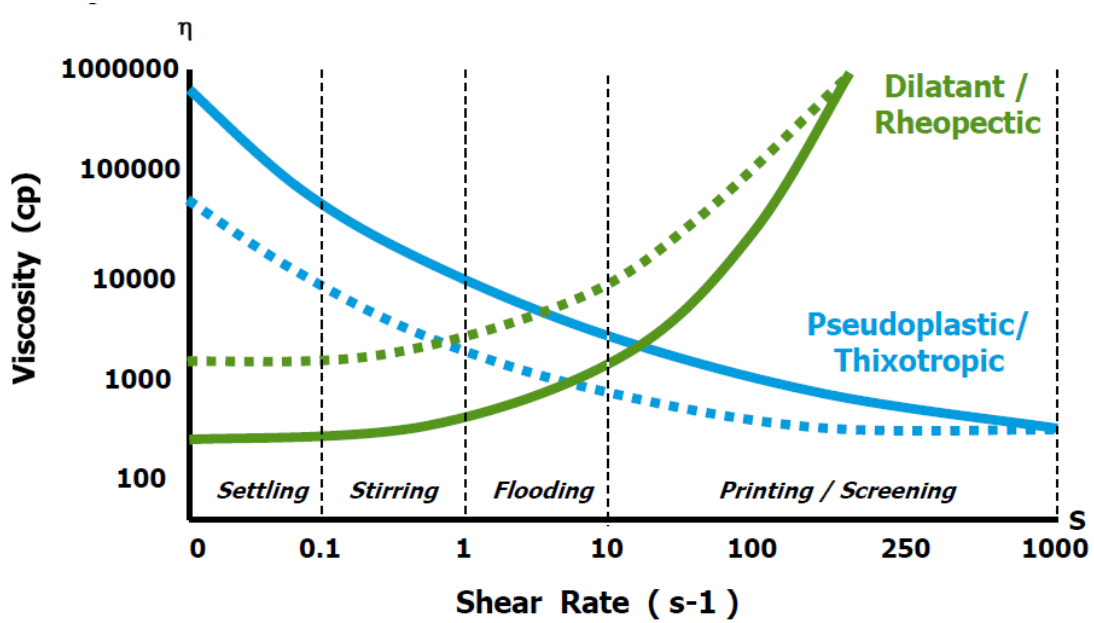


Image done with a MarSurf MfM Premium 9.3.10200

Conductive material

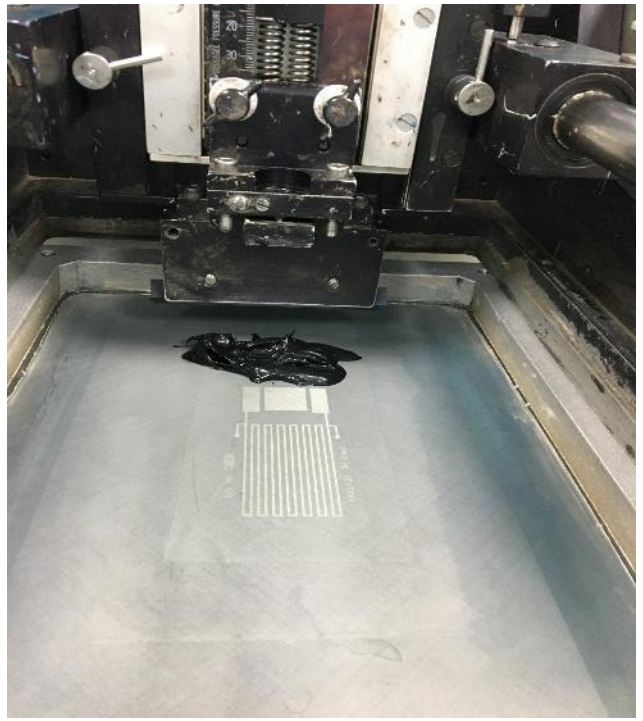
- Pseudoplastic/thixotorpic paste (from 10 Pa.s up to 600 Pa.s).

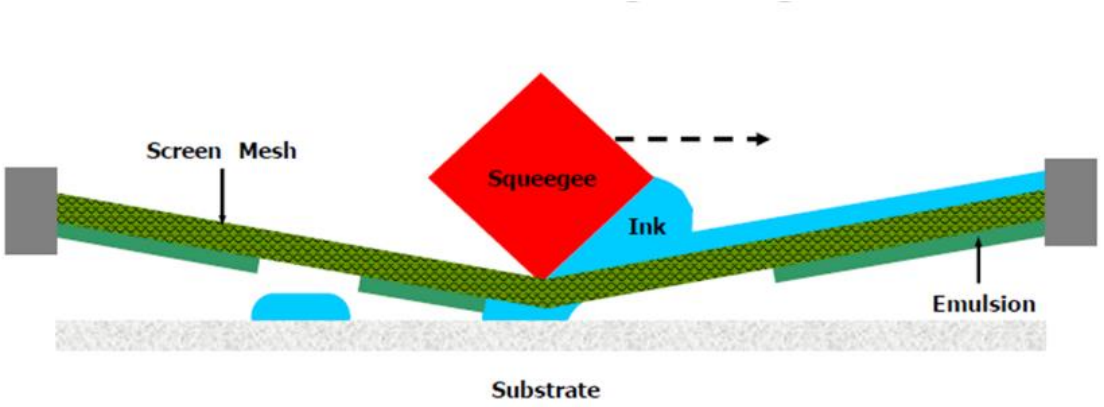




Deposit process

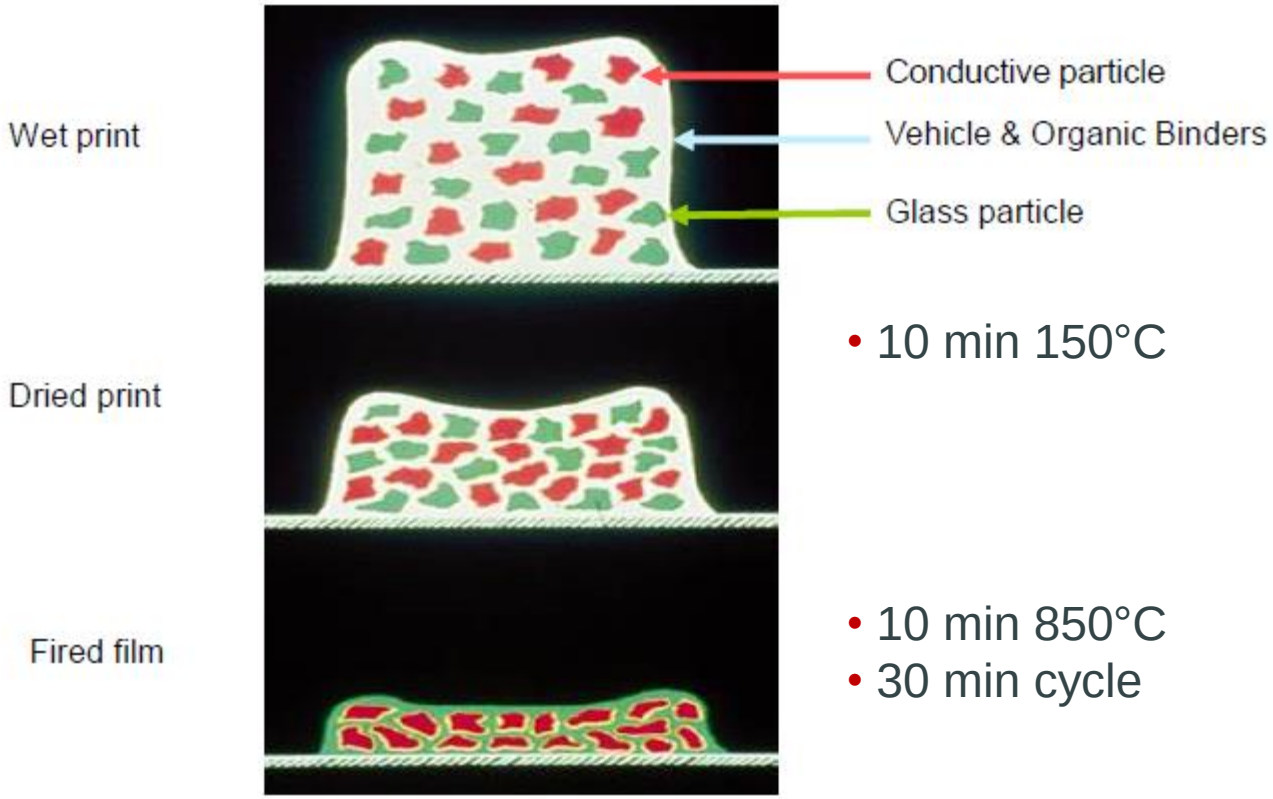
Applied by screen printing with polyester or metal mesh on substrate (mostly Al2O3 or PET)





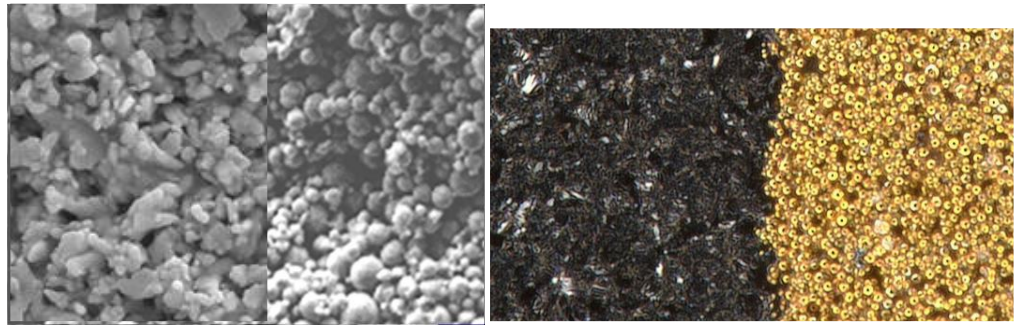
Drying and sintering process

- Dried in an oven to evaporate solvent or sinter particle.

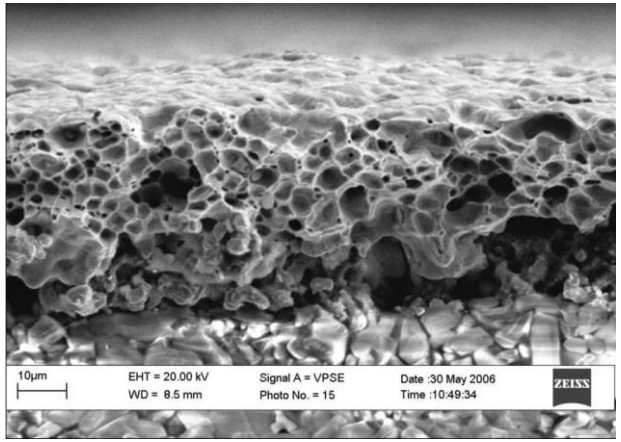


- 10 min 150°C

- 10 min 850°C
- 30 min cycle



Dried state



Sintered state

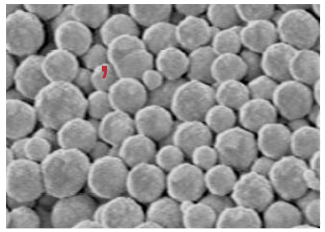
Paste composition

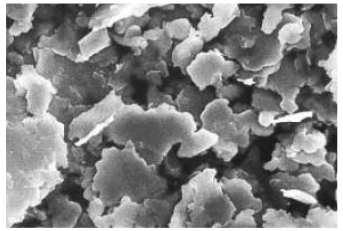
binders

Solvants

Véhicule

Fillers: Metals, alloys,



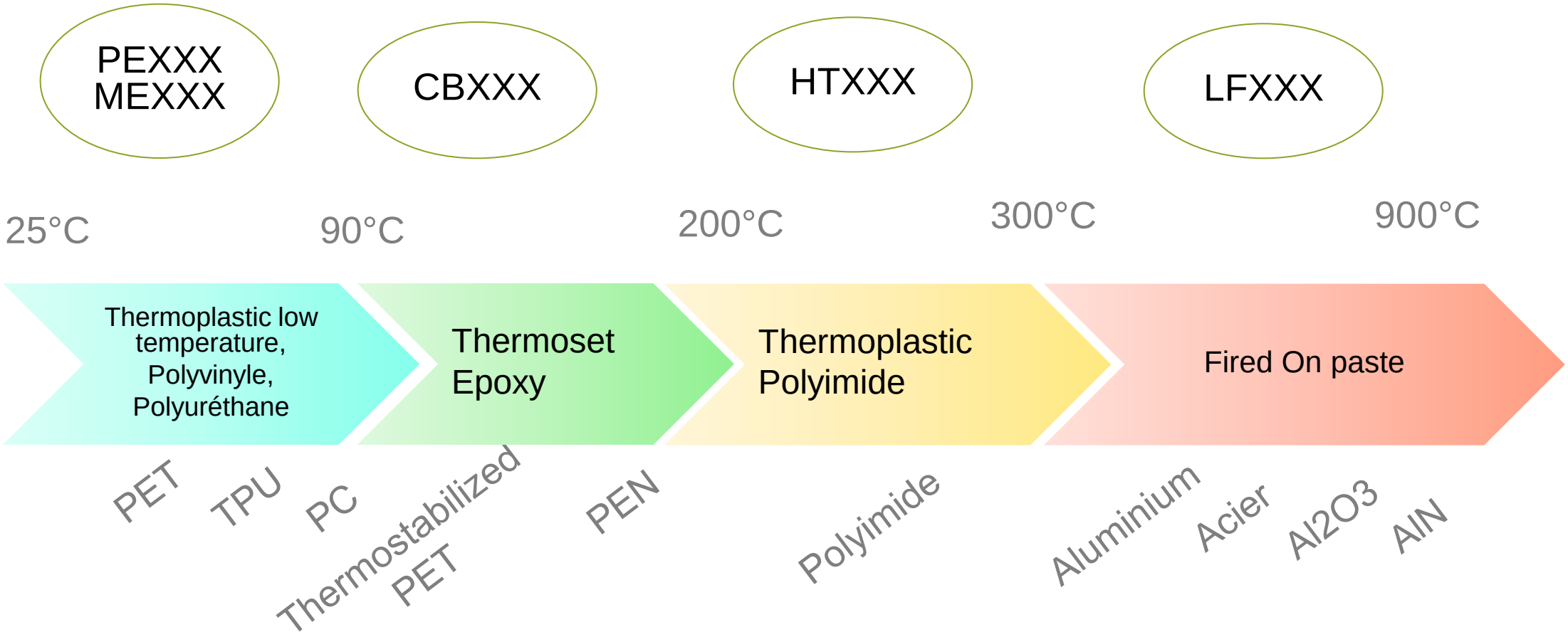


oxides, glasses

Thickfilm Technology

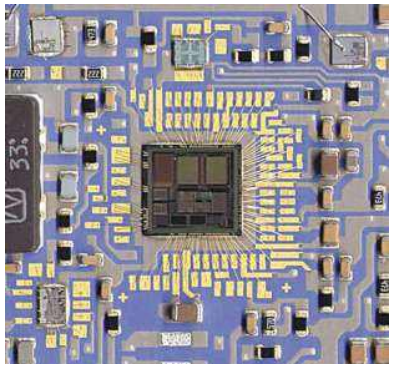
TYPES AND EVOLUTION

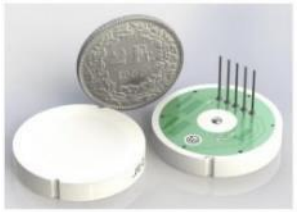
Operating temperature and paste type



Fired on paste

LFXXX
LLXXX
series





Metallux

450°C

Pace maker MSE

Galileo satellite

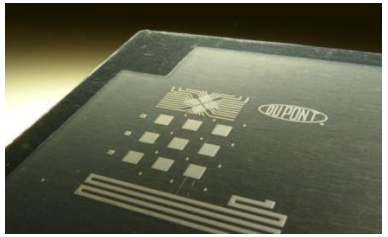
900°C

Thermoplastiques basse température Polyvinyle, Polyuréthane

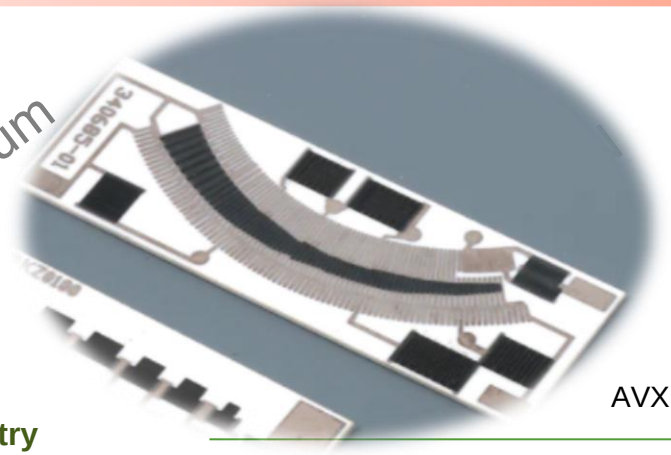
Thermoset Epoxy

Thermoplastiq Polyimides

Fired on paste



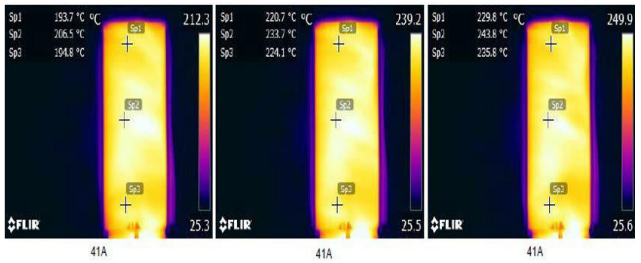
Aluminium



LTCC

AVX Kyocera

Polyimide pastes



200°C

HTXXX

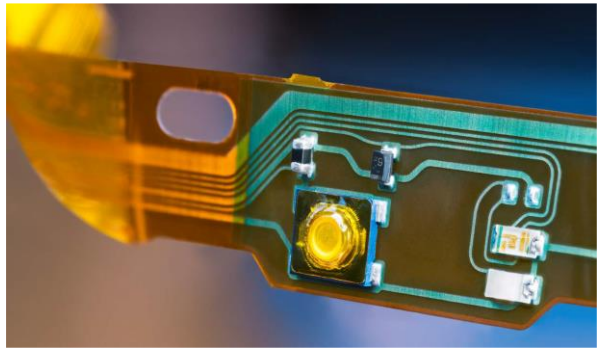
300°C

Thermoplastiques basse température Polyvinyle, Polyuréthane

Thermoset Epoxy

Polyimide

Frittables amique »



Polyimide

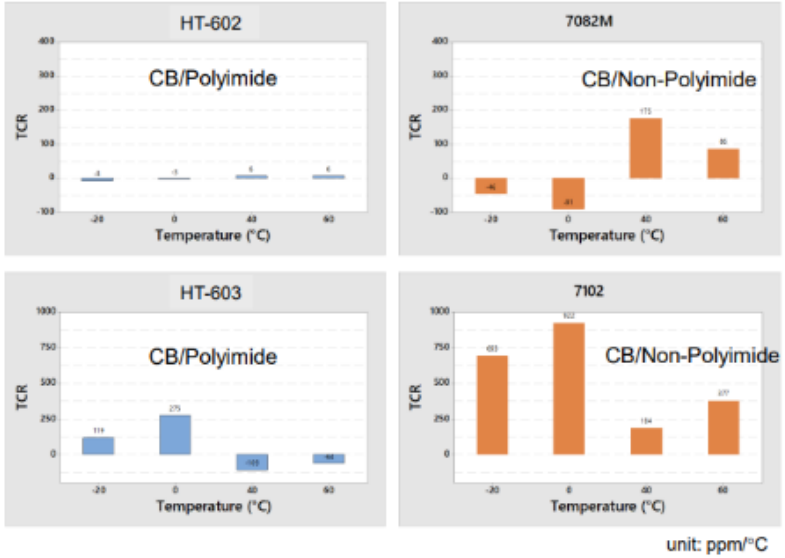
Aluminium

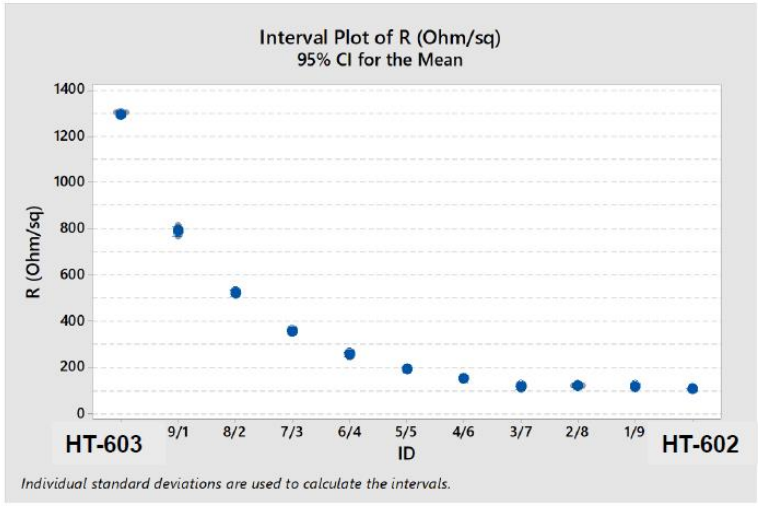
Acier

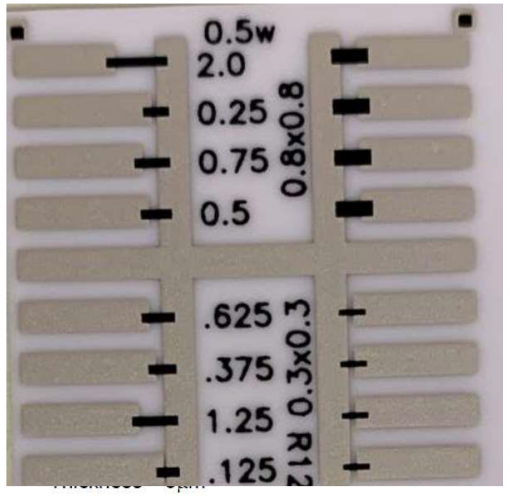
Al2O3

Polymide system

	Previous Products	New Products F-free PI binder	Improvement Higher Thermal / Chemical Resistance
Dielectric - Inorganic Filler	KA701 Fluorinated PI binder	**HT-702**	•Higher Dielectric Strength
Resistor -CB filler	7082M, 7102 Non-PI binder	**HT-602 ; HT-603**	•Lower TCR
Conductor - Ag Flakes	KA801 Fluorinated PI binder	**HT-802**	







Thermoset pastes

CBXXX

90°C

200°C

Thermoplastique basse température Polyvinyle, Polyuréthane

Thermoset Epoxy

noplastique mides

Frittables « Céramique »

PET

TPU

PC

PET Thermostabilisé

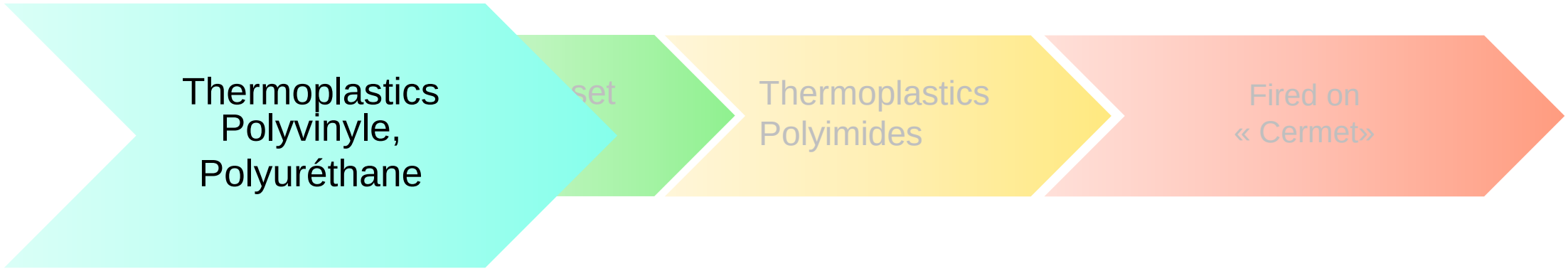
PEN

Polyimide

Polymeric / printed electronics pastes

PEXXX
MEXXX
50XX

25°C 90°C 200°C



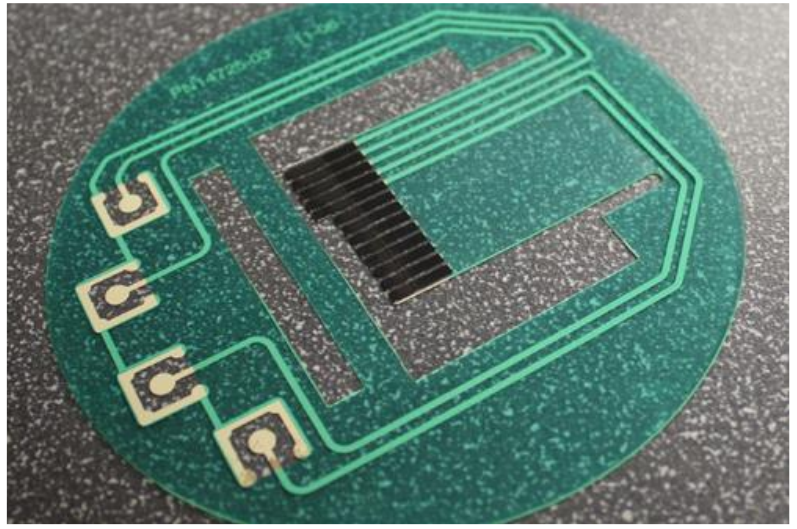
PET
TPU
PC
PET Thermostabilisé
PEN
Polyimide

Standard pastes

1970s first membrane switch touch

3 pastes used in the design:

Pate Micromax	charactéristics
5025	Silver < 12mOhm/sq/mil MOT= 100°C
5018G	UV dielectric BDV >500V/25µm DK= 4,4
7102	Carbon Scratch resistance >2H, Used for connectors 25 Ohm/sq/mil



MEDICAL APPLICATION

Point of care

wearable

Smart patch and electrodes

LIVEO™

DUPONT™

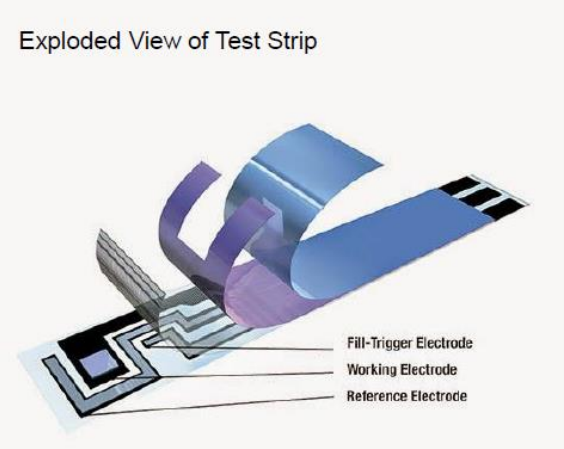
Medical application

BIOSENSOR – POINT OF CARE

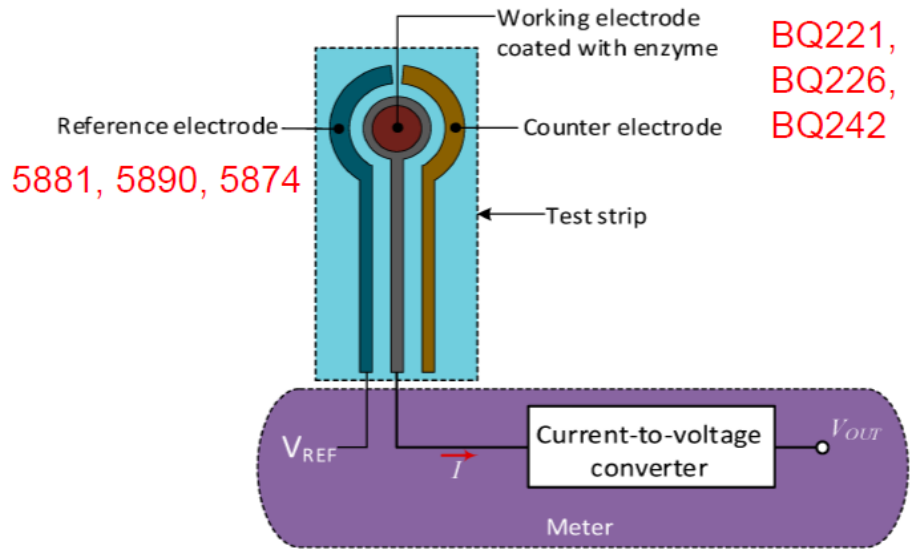
Blood Glucose Test Strip principle

Blood glucose test strips were first introduced in the 1980s and are being continuously evolved to deliver higher accuracy.
The electrical signal from a chemical reaction is measured.
An example of a blood glucose biosensor construction would use:

- Carbon
- Ag/AgCl
- Enzyme



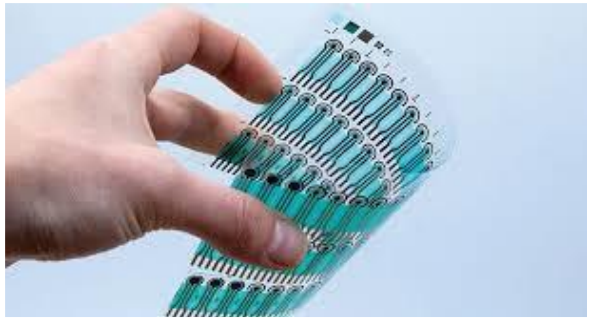
Electrical principle

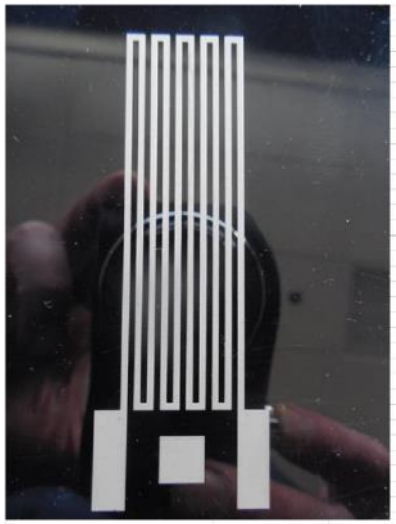


Solvent resistance development

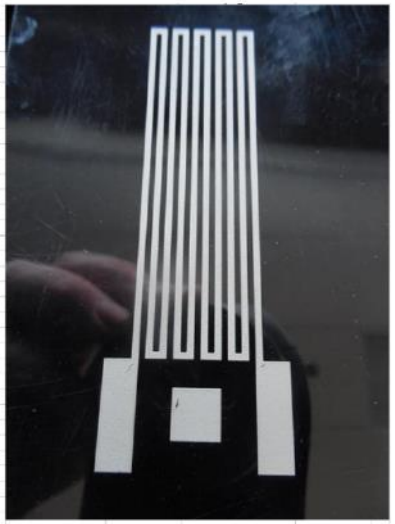
Why solvent resistance?
Some sensors require a membrane coating over the electrode, so the electrode has to be solvent resistant to the solvents used in the membrane formulations:

–THF	Ethanol
–Acetone	Methanol
–MEK	Isopropyl alcohol
–DMSO	Ethylene glycol
–DMF	Most others

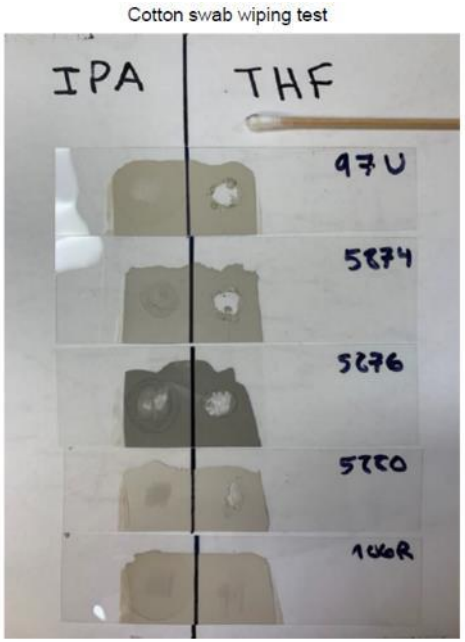




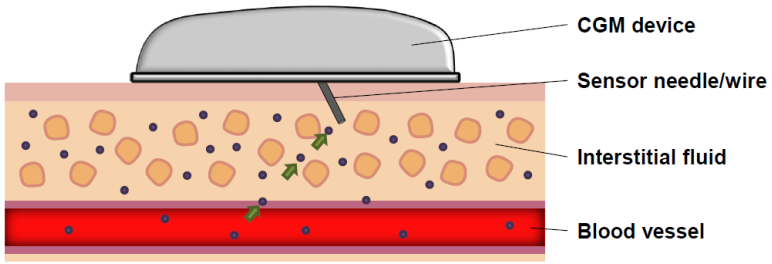
106R – Before THF soak
130C / 20min Drying
Rs = 58 mohm/sq/mil



106R – After THF soak / 30min
100C / 15min Drying
Rs = 54 mohm/sq/mil



Wearable development



Glucose diffuses from blood to interstitial fluid where it can be detected by the sensor.

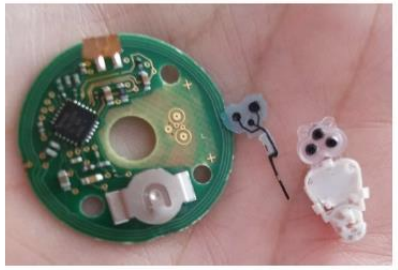
The device is deployed as a skin patch with a needle containing a sensor which is inserted below the skin.

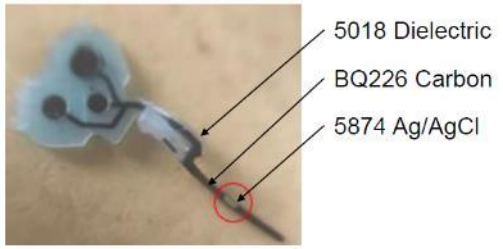
The sensor measures glucose concentration in the interstitial fluid.

The device processes the information and communicates with a reader (e.g. a smartphone) wirelessly to inform the user, or other relevant devices in a diabetes management ecosystem.

Device wear time is typically 5-14 days, and varies by product and manufacturer.

CGM (continuous glucose monitoring) patches allow continuous monitoring up to 14 days without need for regular invasive blood testing using test strips
Integrates printed electronics, skin adhesives and engineering polymer technologies.





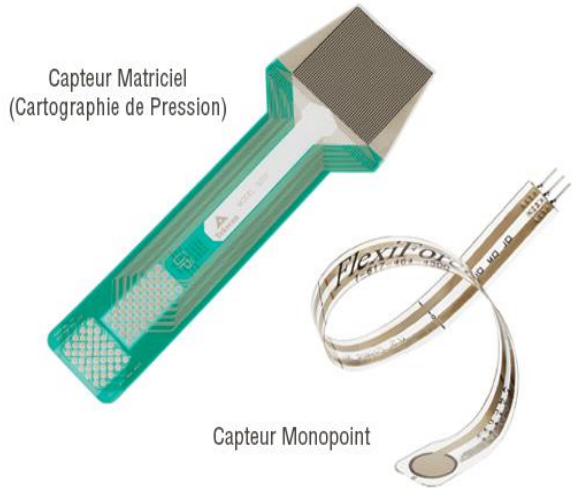
Medical application

WEARABLE APPLICATION

Pressure Sensor

Paste sensitive to force, piezo-resistive

Pressure sensor matrix for pressure distribution of teeth



Tekscan

Pressure sensor matrix for foot pressure measurement, diabetics

IEE

Wearable development

- Wearable requirement :
  - Functionnal after washing at 30°C of best 60°C
  - Stretchable up to 20%, 40% or more for gloves
  - Biocompatible for skin

Socks to measure ECG

Short to monitor or train patient, muscle

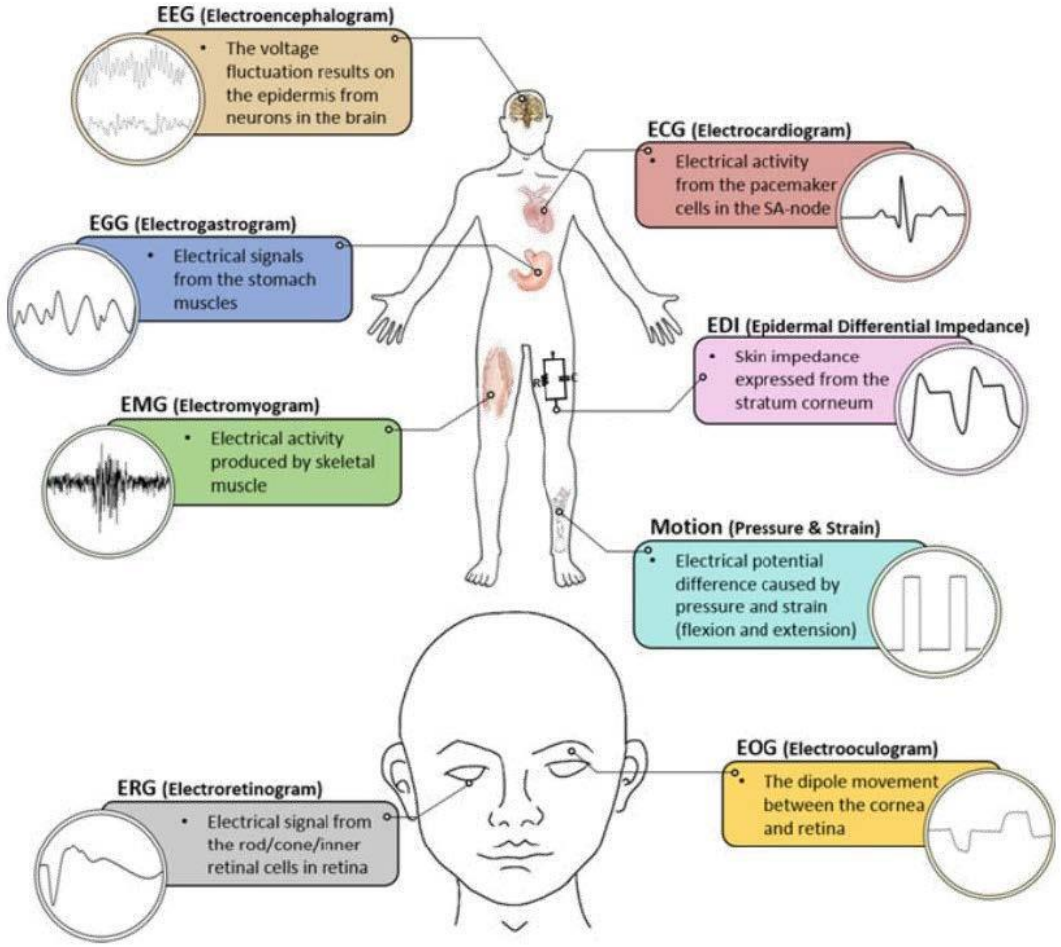
Pregnancy belt

Owlet

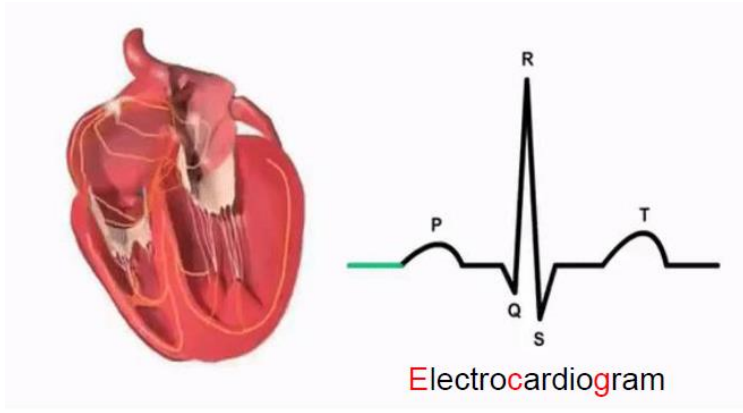
Medical application

SMART PATCHES AND ELECTRODE

ECG signal



Trace of electrical signals generated from heart muscles contracting to pump blood
Small peaks and troughs are indicators of heart function and used by cardiologists to detect potential conditions like atrial fibrillation (heart murmur)

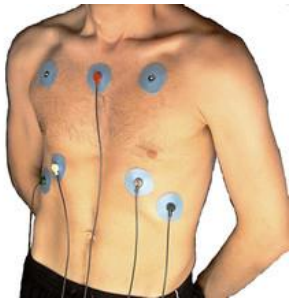


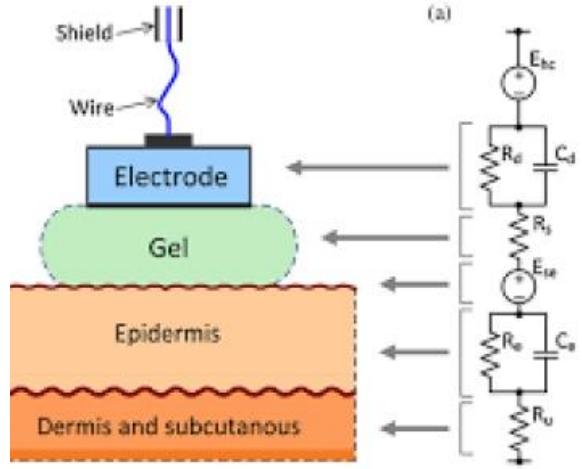
Gel Electrode

- Single use disposable electrode
- Connected by cable
- Used for up to 24 hours
- Typically uses Ag/AgCl electrode (5880, 5881,…)
- Use hydrogel to make skin contact
- Mature large volume commodity business in use for > 40 years

but

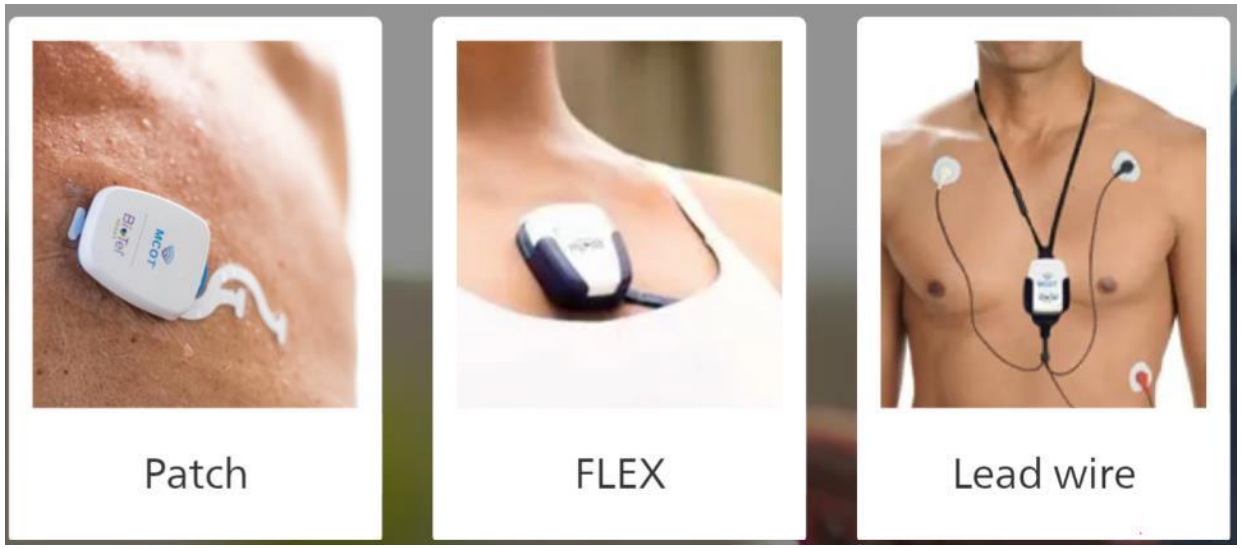
- Gel can cause skin irritation particularly of fragile skin enfants & seniors
- Limited use time
- Cable limits movement
- Shelf life limited due to drying of gel





ECG monitoring – Existing solution

- Standard : Holter, leadwire

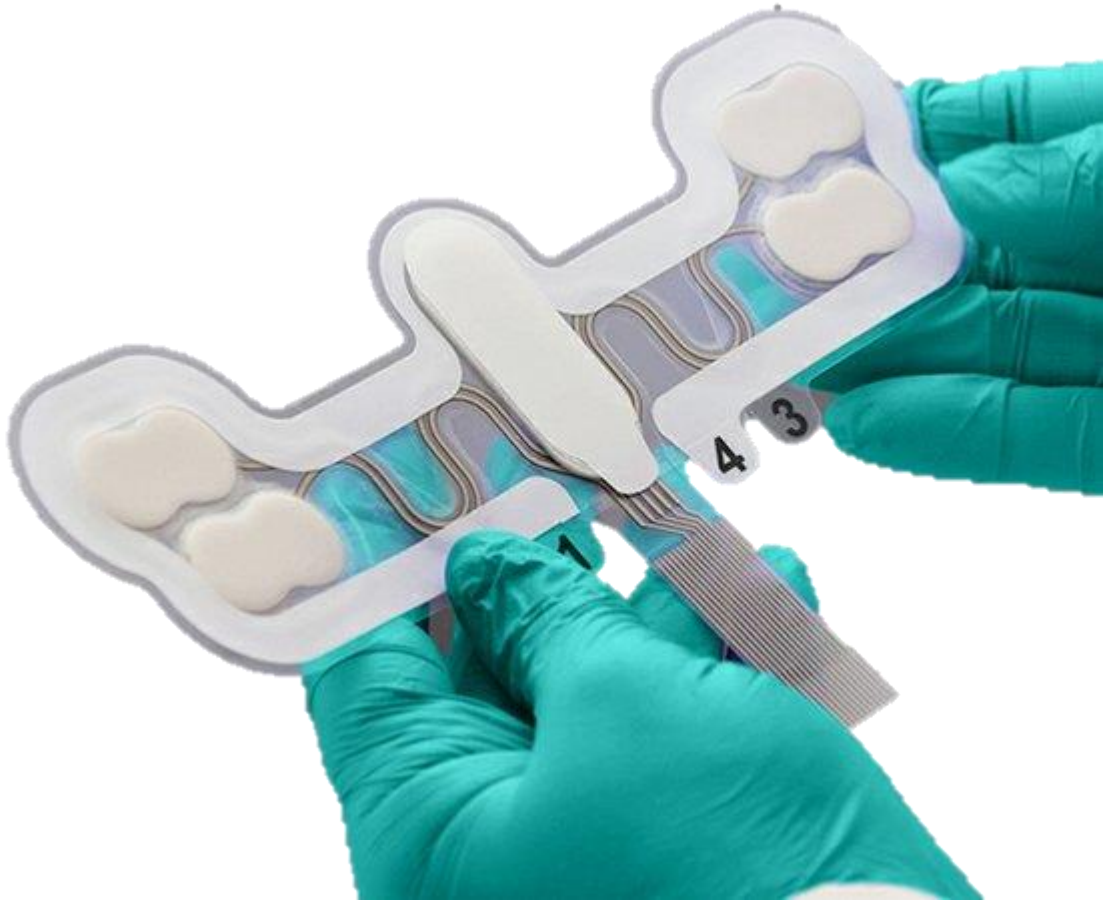


Philips website

ECG electrode – wearable patches

Needs for long term monitoring patches:

- Comfortable substrate
- Biocompatible system
- No gel electrode that dry over time.
- Comfortable adhesive resistant to sweet

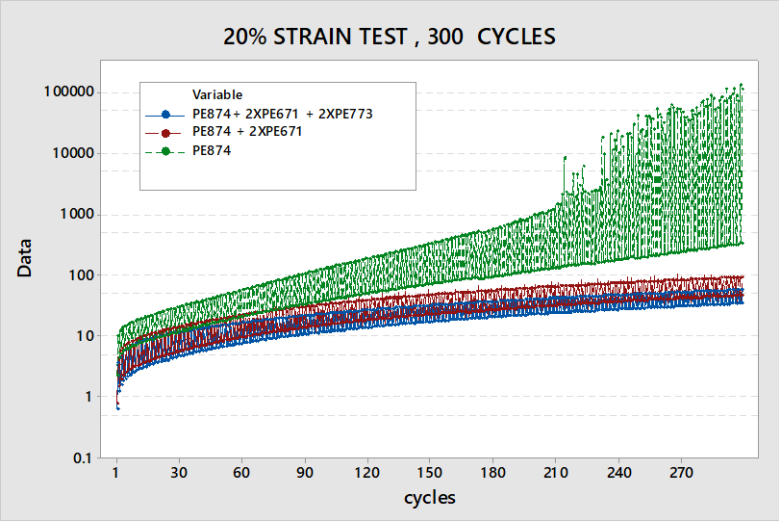


Patch proof of concept

- Multiple electrodes-sensor platform for clinical-grade data
- Disposable patch – reusable electronics
- Stretchable circuitry on stretchable substrate for more conformability
- Waterproof for use in shower
- Long-term monitoring: Wearable up to 7 days, working towards 14 days
- Wireless ..uses Bluetooth to connect
- Allows transmission of data from home

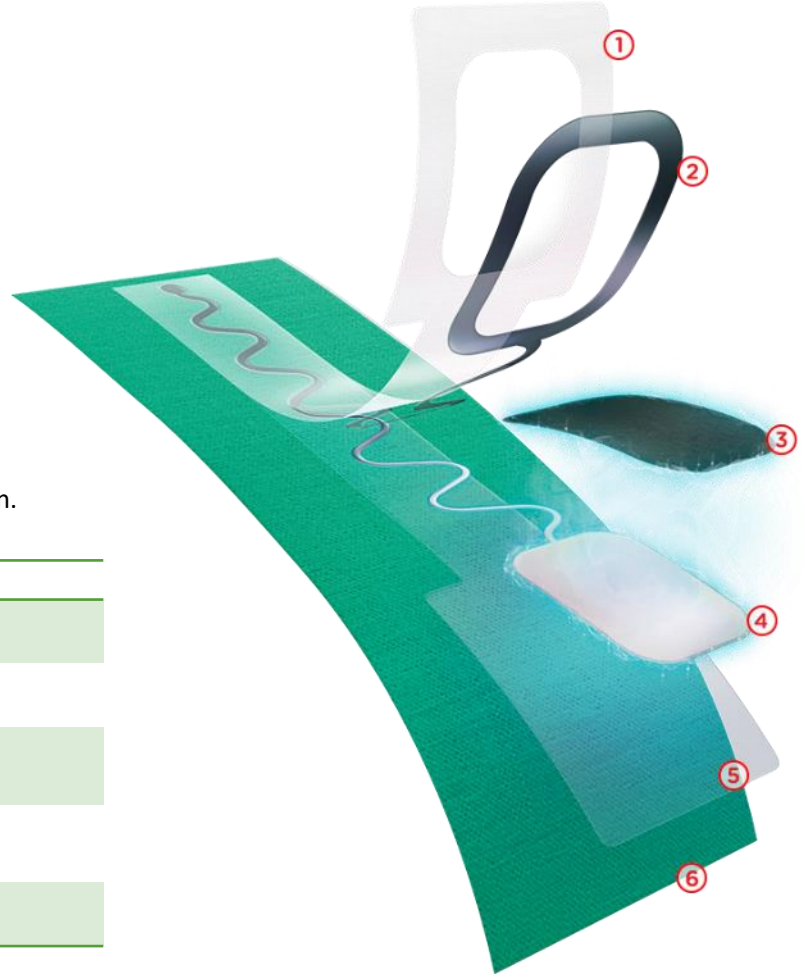
*Collaborating with Holst and Pronat, DuPont has developed the Nighthawk patch, a **medical adhesive patch** for remote, long-term monitoring combining DuPont Liveo™ Silicone and Intexar™ screen-printed ink technologies.*

INTEXAR system for stretchable circuit



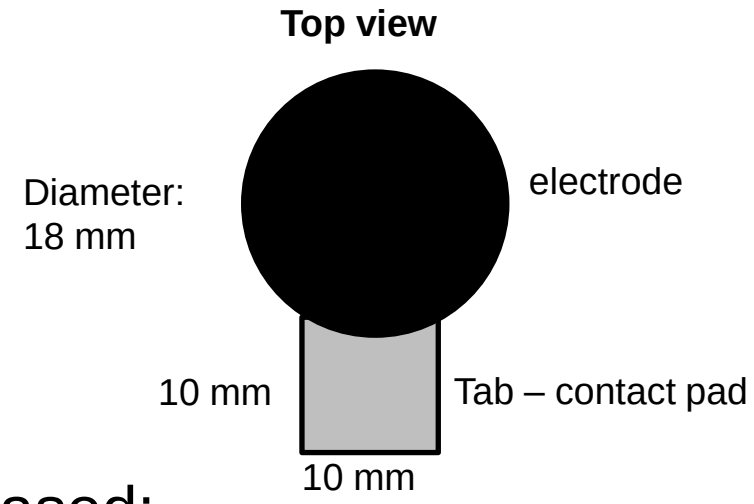
Ink on TE-11C base film bonded to polyester/Lycra blend fabric. 10cm x 0.2cm conductor. Strain rate 508 mm/min.

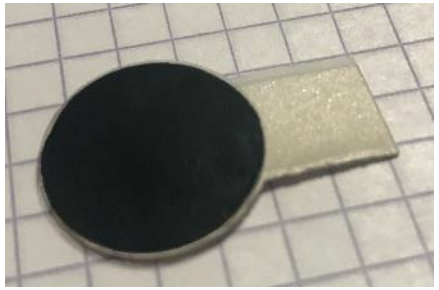
	Product ID	Description
1	PE773	Stretchable encapsulant
2	PE671	Carbon for sensor and overprint
3	PE876	Stretchable silver conductor Best washability
4	PE874	Stretchable silver conductor Best stretch recovery
5	TE-11C	TPU Film with hotmelt adhesive layer

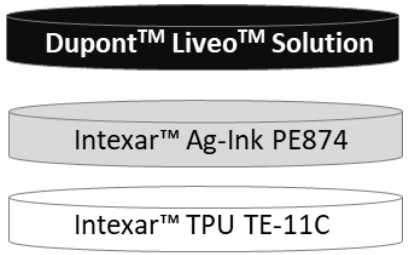


Liveo dry electrode

Single Electrode Set up







Silicone based:
- Soft electrode
- No drying over time
- Waterproof, doesn't take water

Conclusion

Thick film technology offer a versatile and robust alternative to flex and PCB.
It has been on the market for more than 50 years in home appliance, medical application, security and the market.

New offerings include stable solvent-resistant inks, flexible/stretchable/washable inks for wearable applications from Micromax.

Dupont launches a new silicon based adhesive dry electrode for patches complementary to their silicone Skin adhesive and encapsulation resin.

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Albert Einstein quote:
“Imagination is more important than knowledge”

Groupe CCI EUROLAM