Capacitive Touch Switch Technology

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2015.04.20

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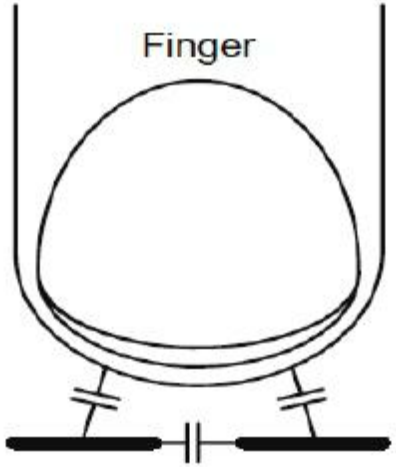
Self Capacitance Principle

- The moving speed of charge is constant, so the greater the capacitance is, the longer the charge and discharge time will be, and the greater the discharge rate will be. Therefore, we can use the length of charge and discharge time and the amount of charge and discharge current to judge the size of capacitance, which has the advantages of high sensitivity and strong anti-noise performance.

- As long as there is a state we can achieve, as long as we can collect a stable state change, we can use this change to achieve a switch signal.



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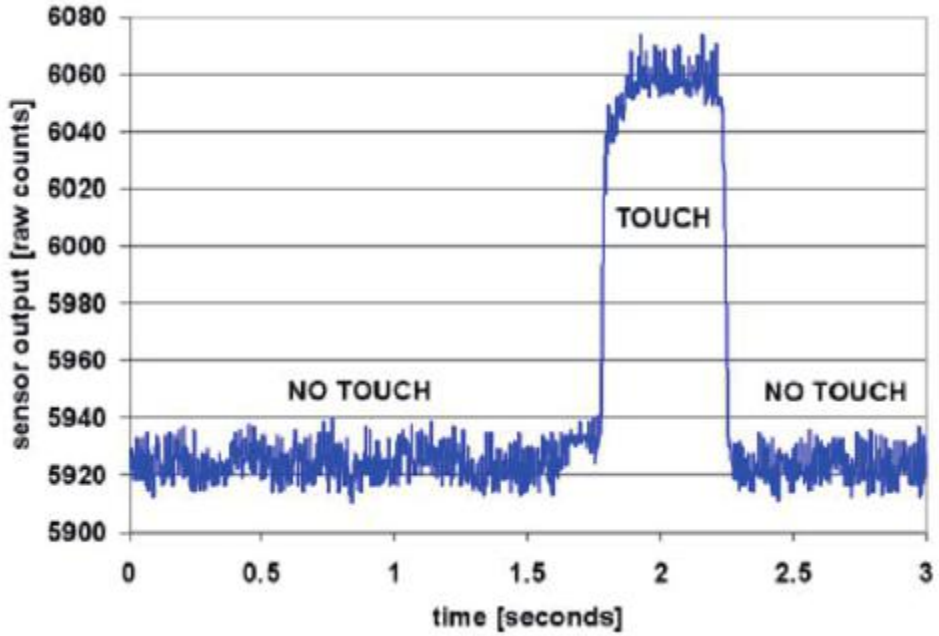
How to use

- After understanding the principle of capacitive touch sensing, how should we use it?
- The self-capacitance is to determine whether there is a finger touching the electrode by detecting the change of the electrostatic capacitance, and scan and detect the capacitance according to a certain cycle, and determine whether there is a finger touching the electrode according to the change of the measured value.
- The MCU scans the specified electrode capacitance according to a certain cycle,

  - When the finger is away from the electrode, the capacitance value remains a stable count value,
  - When a finger approaches or touches, the capacitance value increases and the count value increases,
  - When the finger is away from the electrode, the capacitance value decreases and the count value decreases and remains at a stable value
  - The count value when the finger is away from the electrode is called the reference value. We superimpose a threshold value on the basis of this reference value as a threshold value. When the count value is higher than this threshold value, the judgment switch is ON, when the count value is lower than this threshold value , The judgment switch is OFF.



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Application

◆ Household appliances, automobiles, industrial controls, etc

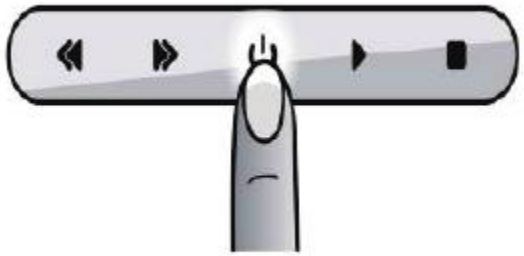
◆ Advantage:

① No mechanical action, no complicated mechanical structure;
② More durable and reliable;
③ PC, PMMA, glass, IML and other integrated designs can be used, with excellent waterproof and dustproof performance;
④ Can easily integrate sound effects and backlight, beautiful and elegant;

◆ Disadvantages:

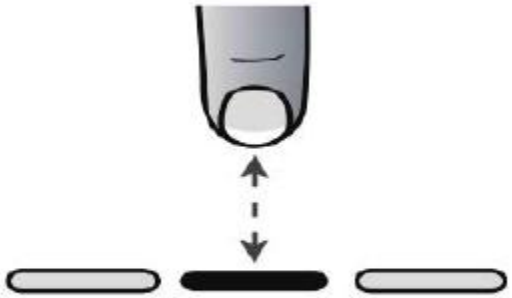
① May be unstable in harsh environments, such as moisture and strong interference;
② Not suitable for occasions requiring strong mechanical tactile feedback, such as heavy industry equipment, medical equipment, etc.

Common Application Types



Button Sensor

Slider Sensor



Proximity Sensor

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Design Constraints

♦ The material of LENS can be non-conductive materials such as plastic and glass, and there should be no conductive materials on it.

① Due to the metal properties of vapor-deposited / sputtered nickel, chromium, and alloys, which have an effect on the sensitivity of touch buttons, we generally use non-conductive plating;

② Screen printing ink with mirror effect, this kind of ink contains metal particles and has metal properties, so this ink will affect the sensitivity of touch keys, and should be avoided as much as possible;

③ According to the working principle of the touch button, the thinner the cover layer is, the better. Because the cover layer of the touch button is located on the surface of the product, it needs to withstand external forces. The thickness is too thin, the strength will not be enough, so the ideal thickness of the cover layer is 1.0- Between 3.0mm;

④ The dielectric constant of air is 1, and the dielectric (air) is more easily polarized by the applied electric field. Air will greatly affect the sensitivity of touch buttons, so the assembly of double-sided tape is also a key process in the production and assembly of touch buttons.

Material	Relative permittivity ε_r
Air	1.0
Dry wood	4.6~4.9
Ordinary glass	7.6~8.0
Ceramic glass	6.0
PET film (MylarR)	3.2
Polycarbonate (LexanR)	2.9~3.0
Acrylic PLexiglassR	2.8
ABS	2.4~4.1
Wood	1.2~2.5
Gypsum	2.5~6.0

$$C_F = \frac{\varepsilon_0 \varepsilon_r A}{D}$$

Note:

ε_0 = Free space dielectric constant

ε_r = Insulation constant of outer coating

A = overlap area between finger and sensor plate

D = Thickness of outer layer

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Design Constraints

⑤ The distance between two sensors should not be less than 3mm (the distance between two adjacent buttons is greater than the thickness of the panel);

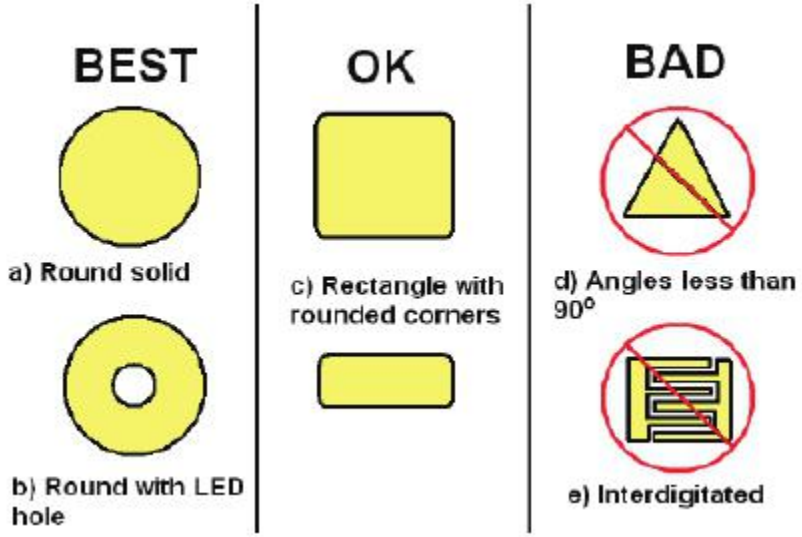
⑥ The size of the sensor should not be < 10mm*10mm;＜10mm*10mm;

⑦ The sensor is generally used in round and rounded squares, and it is not recommended to use special shapes, such as triangles;

⑧ The recommended distance between the sensor and the reference ground is 0.5mm-2mm;

⑨ The button edge distance from the panel contour edge should not be < 3.5mm;

⑩ The sensor lead should not be too close to the interference source (high current, high frequency signal).



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Common Application Structure

1. Copper foil coupled electric field (a design method based on PCB)

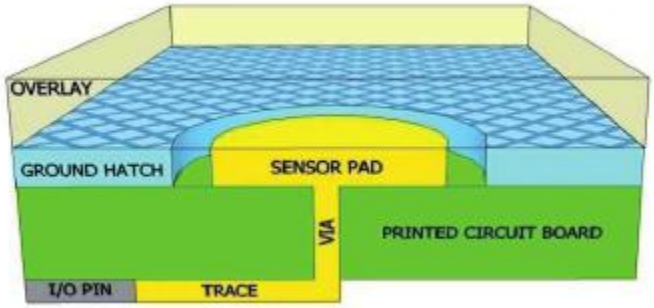
Features are as follows:

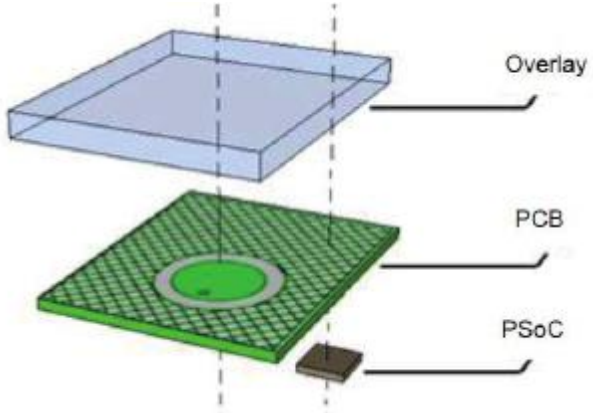
① The copper foil etched on the PCB surface is directly used as the sensor, low cost;

② The electric field is emitted from the copper foil sensor and points to the ground plane;

③ Instead of using mechanical moving parts, use an insulating cover as the touch surface of the keys;

④ Simplified structure, ideal plan for pure plane board design.





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Common Application Structure

2. Spring coupling electric field (a PCB based design method)

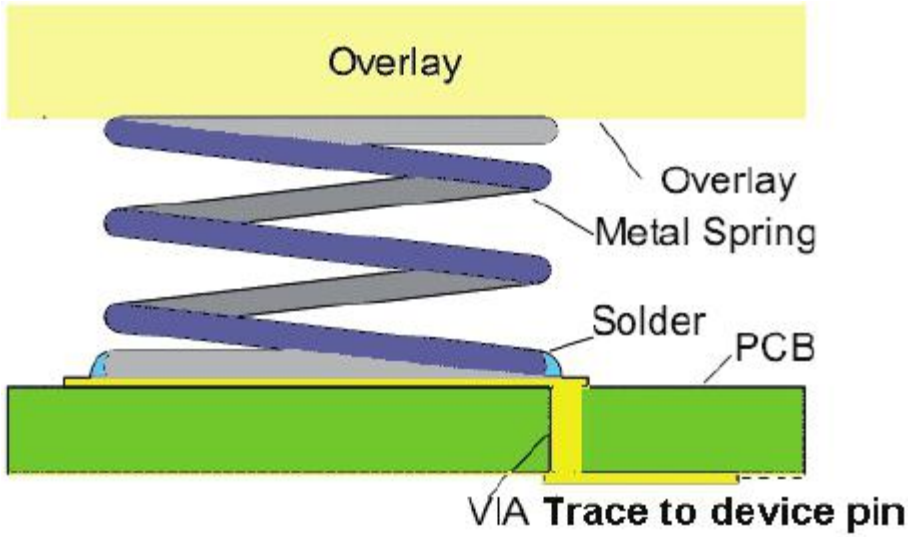
♦Features are as follows:

① The electric field is coupled from the PCB to the cover layer through the compression spring;

② Use conductive material as the connection point of capacitive sensor;

③ No mechanical moving parts are used, and the spring does not move;

④ Avoid the ideal method of double-sided adhesive bonding process.



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Common Application Structure

3. Coupling electric field through conductive ink (a design method based on conductive ink)

- Features are as follows:
  ① The electric field is coupled with the cover layer through the conductive ink printed on the flexible substrate;

  ② Adopt flexible base material, so the use flexibility is very high;

  ③ The production cost is low and the shape can be customized;

  ④ Ideal solution for flexible panels.

4. Coupling electric field through transparent conductive ink (PEDOT) (a design method based on PEDOT)

- Features are as follows:
  ① The electric field is coupled with the cover layer through the transparent conductive ink printed on the flexible substrate;

  ② Adopt flexible base material, so the use flexibility is very high;

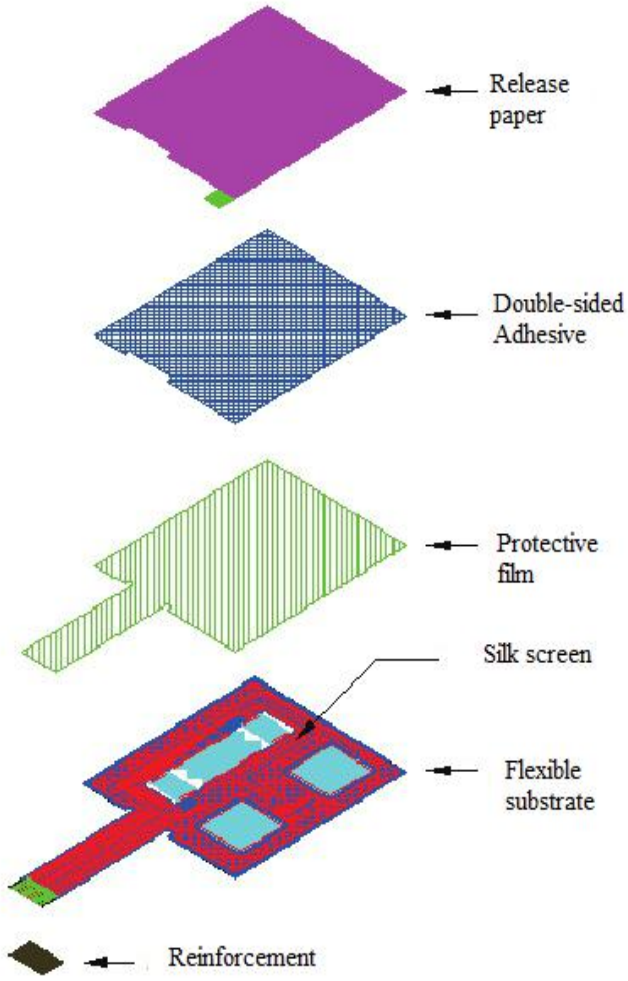
  ③ The production cost is low and the shape can be customized;

  ④ The transparent flexible material cooperates with the transparent conductive paste to make the sensor, which provides the integrated backlight effect for the button great convenience

  ⑤ Ideal solution for flexible backlight panel.

Typical Structure of Capacitive Touch Switch

- Release paper: users can peel off the release paper and stick it on the application surface
- Double-sided adhesive: selected according to application requirements
- Protective film: provides protection for screen printing inks
- Screen printing circuit: screen printing conductive ink and insulating ink to achieve function
- Flexible substrate: commonly used highly transparent PET with a thickness of 0.125mm
- Reinforcement: select the required thickness according to different connectors



Basic information required:

- Transparency: generally 70%, maximum 85%
- Assembly method: OCA & PSA / Pressing
- Conductive surface direction:
- Connector form:
- Overlay layer: 1. Thickness (reference for the gap between the key and the key)
  2. Material;
  3. Surface treatment
- Total thickness:
- Surface treatment: whether to do light diffusion treatment / printing characters

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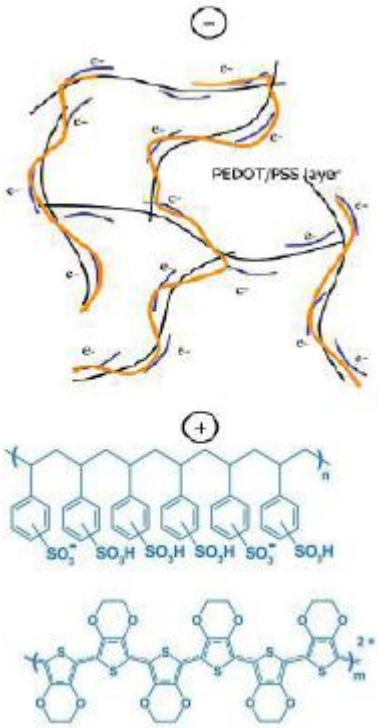
Transparent button can be realized in first way:

1. Transparent conductive oil (PEDOT: PSS)

PEDOT: PSS (the molecular structure is shown in the picture on the right) is an aqueous solution of high molecular polymers with high conductivity. According to different formulas, aqueous solutions with different conductivity can be obtained.



◆ Features:

① High transmittance: T≥70% (visible light)

② Low resistivity: ≤500Ω / sq

③ Good ductility

(Suppliers include Agfa, Heraeus and Heraeus)

◆ Process flow:

Blanking ⇨ Printing ⇨ Testing ⇨ Assembly ⇨ Die cutting ⇨ Testing

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The transparent button can be realized in the second way:

2. ITO (Indium Tin Oxide)

ITO is obtained by plating indium tin oxide on the PET film through the magnetron sputtering method. Because indium oxide has the characteristics of high transparency, tin oxide has the characteristics of high conductivity, so that the ITO film can have high permeability and high conductivity characteristic.

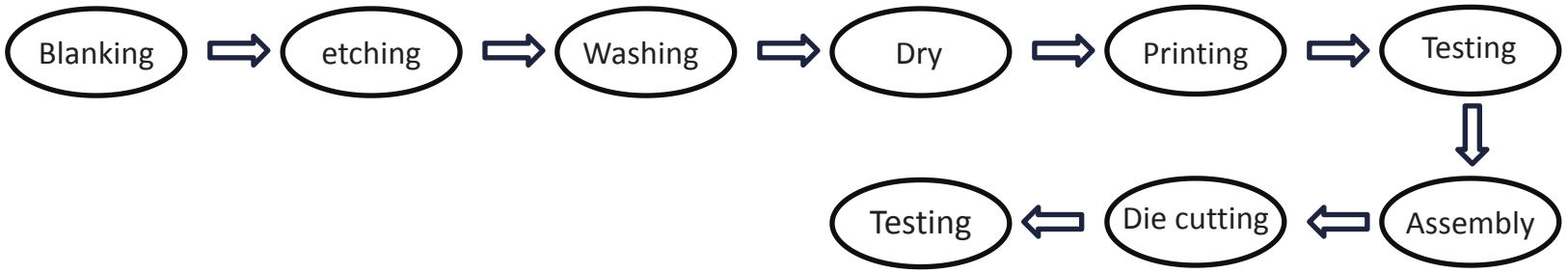
◆ Features:

① High transmittance: T≥85% (visible light)
② Low resistivity: ≤100Ω / sq
③ The coating is fragile and has poor ductility, so it cannot be made into a flexible product
④ High cost of vacuum coating
⑤ The etching process is not environmentally friendly

Current alternative ITO solutions are:

1. Silver Nanowires
2. Metal Mesh (Metal Mesh)
3. PEDOT / Conductive Polymers polymer)
4. Graphene (graphene)
5. Carbon Nanotubes (carbon nanotubes)
6. ITO inks (ITO ink) and other technologies

◆ Process flow:



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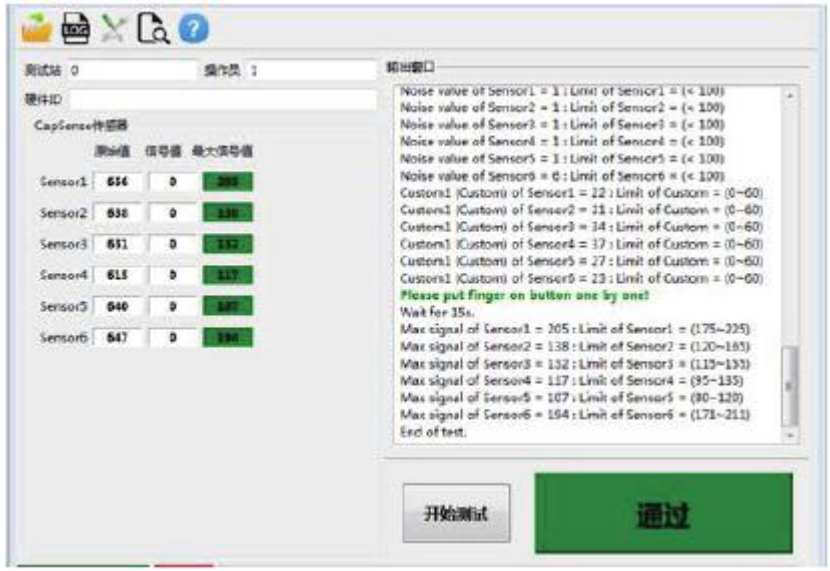
Production Function Test:



配置 | 传感器 | 一致性 | 寄存器

传感器数量 6 定制项数量 1

名称	原始值	信号值	定制项1
Sensor1	4,5,3500,2048,100	6,7,1000,300,3,0	Cp1,1,8,60,0
Sensor2	10,11,3500,2048,100	12,13,1000,300,9,0	Cp2,1,14,60,0
Sensor3	16,17,3500,2048,100	18,19,1000,300,15,0	Cp3,1,20,60,0
Sensor4	22,23,3500,2048,100	24,25,1000,300,21,0	Cp4,1,26,60,0
Sensor5	28,29,3500,2048,100	30,31,1000,300,27,0	Cp5,1,32,60,0
Sensor6	34,35,3500,2048,100	36,37,1000,300,33,0	Cp6,1,38,60,0

Testable items:

1. Original signal value
2. Touch signal value
3. Signal value of parasitic capacitance
4. The test data of each product can be saved separately

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Commonly Used Material

Name	Model	Thickness	Brand	Remarks
PET	A4360	0.125mm	Toyobo	Shrink strip: oven piece 135℃, 60min
	4517	0.125mm	Mitsubishi	
	HK-33WF	0.125mm	Dong	
OCA	3M8146-5	0.125mm	3M	Can be posted on PEDOT
Single-sided adhesive	SP-25TA	0.05mm	New asia	Can be directly attached to PEDOT for protection
Double-sided adhesive	W-217H	0.10mm	Soken	
	3M467MP	0.05mm	3M	
	3M468MP	0.125mm	3M	
	3M8173D	0.075mm	3M	
Cotton	IXPE	0.30mm		
	IXPE	0.50mm		

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Common Materials

Name	Model	Brand	Remarks
PEDOT	SV4Stab	Heraeus	Bright
	EL-P5015	Kefa	Brightness, resistance and stability are better
Protective oil	9399		Can be brushed on PEDOT
Diffusion oil	IDL-2	Lear	Can be brushed on PEDOT, brush on both sides can get good light diffusion