Order code	Manufacturer code	Description
06-1270	n/a	THERMOCOLOUR SHEET 150MM X 150MM (RE)

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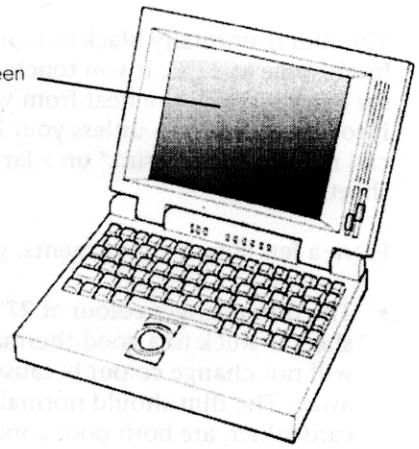
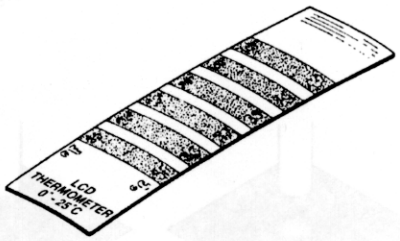
THERMOCOLOUR FILM

Many products such as calculators and laptop computers show information using liquid crystal displays (LCDs). Liquid crystal is a very unusual material which responds to electrical signals.

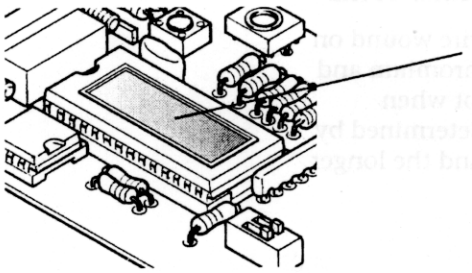


Thermochromic liquid crystal is a special form of the LCD material, but one which changes colour when heated. It is put into minute capsules by a process called microencapsulation and then made into an "ink" for printing onto plastic or paper. Thermochromic ink has a number of uses including:

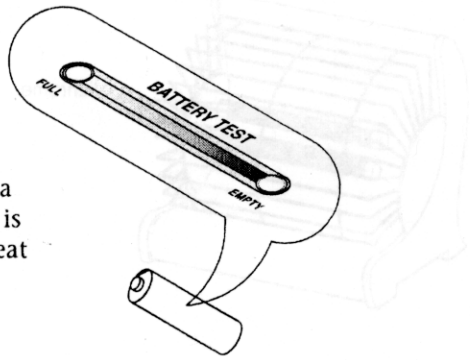
- thermometers which change colour along their length according to temperature,



- warning patches which show when something such as a computer chip is getting too hot,



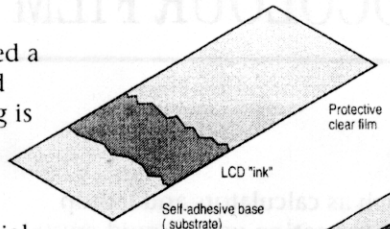
- battery test panels.



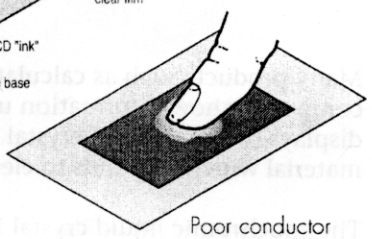
In battery test panels thermochromic ink is printed on a material that heats up when current passes. If a battery is good, enough current passes through the material to heat up the ink and cause it to change colour.

TEP's Thermocolour Film

Thermocolour film consists of a plastic film (called a substrate) which has an adhesive on one side and thermochromic ink on the other. The ink coating is protected by a clear plastic film.



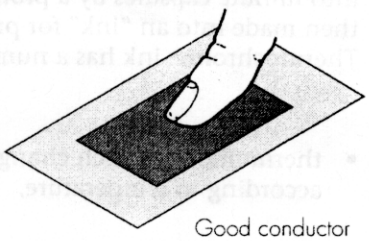
The film is normally black but changes colour to bright blue at 27°C. If you touch a piece of material for a few seconds the heat from your finger will cause it to change colour - unless your hands are cold ! You can make a "hand print" on a larger piece of the sheet.



Poor conductor
e.g. card or plastic

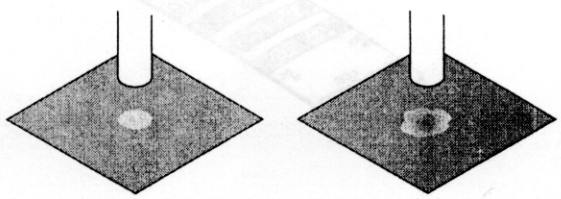
From a few simple experiments, you will see that:

- The film changes colour at 27°C. If your hand is cold or the sheet is stuck to a good thermal conductor such a metal, it will not change colour because the heat will be conducted away. The film should normally be bonded onto plastic or card which are both poor conductors of heat. If it has to be fixed to a metal base, an insulating layer (e.g. foamcore board) should be placed between the thermocolour film and the metal.



Good conductor
e.g. copper

- Thermocolour sheet takes a little time to warm up but when the source of heat - e.g. your finger or a heated rod - is removed, the film stays warm for a short time. The blue colour then changes slowly to pale yellow and back to black. Also, if you watch the blue area, it continues to spread out slightly after the source of heat is taken away. This is because heat is conducted slightly through the film and affects the surrounding ink.

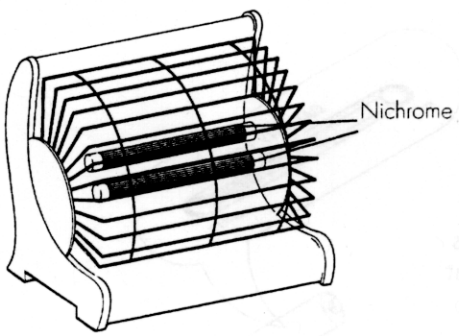


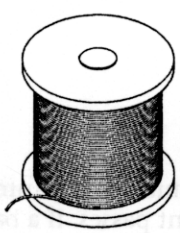
1. heated rod causes colour change

2. colour changes to yellow and spreads out

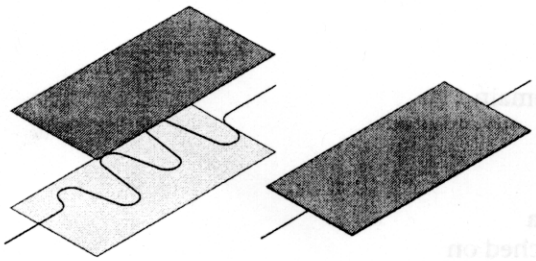
Heating Thermocolour Film With Resistance Wire

Many electric fires have an element of **nichrome** wire wound on a ceramic rod. Nichrome is an alloy (mixture) of Chromium and nickel. It has a high electrical resistance and gets hot when current passes. The resistance of nichrome wire is determined by its diameter and length. The smaller the diameter and the longer the length, the higher the resistance.

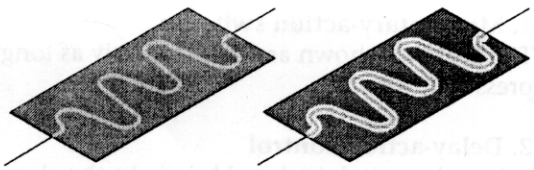




If you lay a length of nichrome wire on the sticky back of thermochromic sheet, it will stay in place until the protective paper backing sheet is replaced. When the wire is heated up using a battery, the film will change colour along the pathway of the wire.



1. Trap wire between adhesive and backing paper



2. Pass current to show effect

Try an experiment using a 100mm length of 0.3mm diameter wire and a 3v battery (e.g. 2AA cells in a battery box).

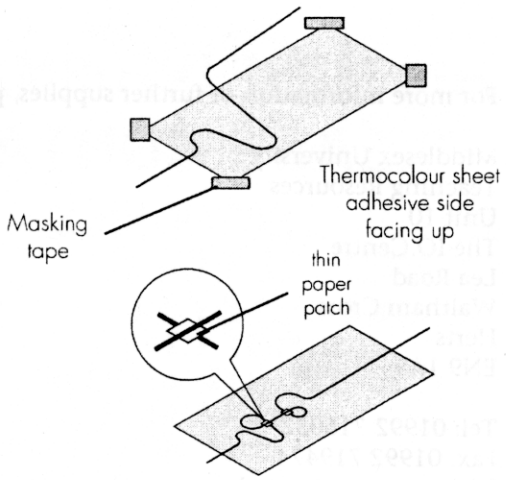
You will see that the longer you heat the wire the more the blue area will spread out. It will continue to spread slightly after the battery has been disconnected.

An Example Design Brief

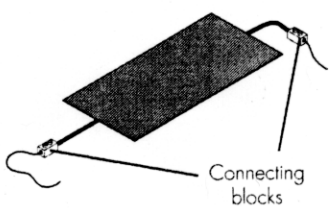
Design and make a liquid crystal display based on thermocolour film and a resistance element. The display is for a purpose which you identify - e.g. a badge, warning device, adversiting display. The display should be controlled by a switch or circuit.

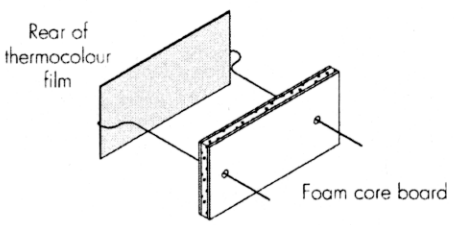
Designing a Thermocolour Display

You might decide to use the thermocolour film to display a logo, sign or even a word. Shaping the thin wire and laying it onto the adhesive back of the film is made easier by taping the film face down with masking tape. The nichrome wire should not cross over itself because there will be a short circuit - as the illustration shows. If the wire has to cross over in your design then use the smallest possible piece of paper as an insulator at the crossing.



The wire ends of the display should be covered, if possible, with heat-proof sleeving and then joined to connecting wires with terminal blocks. If the display is mounted, for example, on foamcore board or the surface of a case, the leads can be passed through holes so that they do not show.





Controlling the Display

Ideally, the display should only be switched on for a short time so that the image does not spread out too much. Suitable control systems include:

1. Momentary-action switches
The switches shown are "on" for only as long as they remain pressed.

2. Delay-action control
When the switch is closed briefly in the circuit shown, a capacitor charges up rapidly and keeps a transistor switched on for a several seconds. The delay period depends on the values of the capacitor and resistor. The higher the values, the longer the delay.

A delay circuit can also be made with a 555 timer chip as shown.

3. Sensor-control
The sensor is part of a potential divider which turns on the transistor. The sensor shown consists of two probes that pass current when bridged by water.

4. Programmable display
The display can be programmed to turn on and off using the TEP Bit by Bit controller. The nichrome wire is connected to one of the transistor outputs. A smartcard controller can also be used which means the program can be stored on a removable card.