

TLC COATED POLYESTER SHEETS

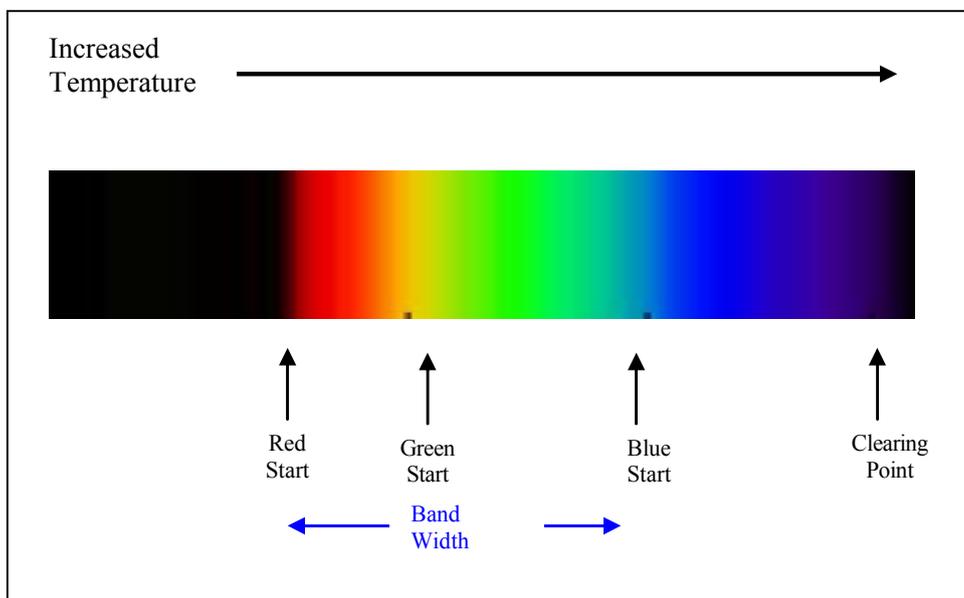
THERMOCHROMIC LIQUID CRYSTALS

Thermochromic Liquid Crystal (TLC) molecules are very sensitive to temperature and change position, or twist, in relation to changes in temperature. This change in molecular structure affects the wavelengths of light that are absorbed or reflected by the liquid crystals, resulting in an apparent change in the colour of the sheet. For example, as the temperature increases, the liquid crystal molecules twist slightly in one direction. This twisting causes the liquid crystal substance to absorb more of the red and blue portions of the visible light, and reflect the green part. This causes the sheet to appear green. When the temperature decreases, the molecules begin to twist in the opposite direction, and reflect a different portion of the spectrum.

COLOUR PLAYS

The colour change properties of TLC sheets are identified by a code called the COLOUR PLAY. This specifies the temperatures at which the colours shown by the TLC change.

The colour play gives EITHER the red start temperature (R) OR mid-green temperature (MG), the temperature scale (C or F) and the bandwidth (W). For example, R35C1W describes a TLC mixture with a red start at 35°C and a bandwidth of 1°C, (i.e.) a blue start 1°C higher at 36°C.



STANDARD PRODUCTS

Standard sheets use a substrate of 100 micron clear polyester (Mylar). The sheets are printed on one side, first with the microencapsulated TLC coating, then with a black backing ink. The colour change properties of the TLC coating are viewed through the clear, uncoated side of the sheet. Standard sheets are available with, or without, adhesive-backing (pressure-sensitive adhesive); the protective release-liner can be removed for easy adhesion to a variety of flat surfaces.

STANDARD SPECIFICATION

Substrate: Polyester sheet, 100 microns thick

Size: 12 x 18" (30cm x 45cm)

Total thickness: Without adhesive: 100-175 microns; With adhesive: 175-225 microns

Colour Change: Black to red, through the other colours of the visible spectrum to blue, with increasing temperature, and finally to black again.

Colour Plays	Red Start (RS) (Black to red)	Green Start (GS)	Blue Start (BS)	Clearing Point (CP) (Blue to Black)	Bandwidth (Blue start minus red start)
	°C	°C	°C	°C	°C
R20C5W	20.0	21.0	25.0	41.0	5.0
R25C5W	25.0	26.0	30.0	44.0	5.0
R30C5W	30.0	31.0	35.0	46.0	5.0
R35C1W	35.0	35.2	36.0	49.0	1.0
R35C5W	35.0	36.0	40.0	49.0	5.0

TOLERANCES

Red start and green start temperatures quoted are $\pm 0.5^{\circ}\text{C}$

Blue start, blue to black and bandwidth temperatures are $\pm 1^{\circ}\text{C}$

CUSTOM MANUFACTURE

In addition to the standard range of sheets, B&H LCR offers a custom-manufacturing service, tailor-making products to customer requirements. TLC red start temperatures can vary from -30°C to $+120^{\circ}\text{C}$ and bandwidths of 1 to 20°C are possible. A wide range of substrates can be used, both rigid and flexible, with different thicknesses, and it is also possible to cast elastomeric films. Specific problems, like UV stability and water-resistance, for example, can also be addressed.

USAGE INSTRUCTIONS

1. Clean surface thoroughly to remove all dirt, grease, etc. Acetone, petroleum ether and similar organic solvents may be used. Ensure that the surface is COMPLETELY dry before proceeding.
2. Remove protective backing from adhesive and place sheet lightly in position on surface. Press down firmly with fingers in centre of sheet and smooth outward, in each direction in turn, to ensure that no air bubbles are trapped between the sheet and the surface.

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3. The sheet is now ready for use as a temperature indicating film.

REMOVAL

After use, the sheet can be removed from the surface by pulling it off, although the sheet will be probably destroyed in the process. Residual adhesive can be removed by washing with a suitable solvent. The choice of solvent will depend on the nature of the surface to which the sheet was attached.

STORAGE

Unused sheets should be stored out of direct sunlight at room temperature (20-25°C), in a solvent-free environment. Sheets in position on test surfaces should be protected from UV light and organic solvents wherever possible. The colour play properties of the sheets should be checked at regular intervals. If stored correctly, the sheets should have shelf lives of up to a year or more.

LIFETIMES

TLC coated sheets should retain their colour play characteristics for many months under normal handling conditions. Continued submersion and temperature cycling in hot (40°C+) water baths will accelerate degradation, as will continued temperature cycling at elevated temperatures in general, and exposure to UV light.

SIMPLE EXPERIMENTS FOR STANDARD PRODUCTS

1. Dampen the tip of a small cloth or sponge with water and "write" with it on the surface of the R20C5W sheet. The evaporative cooling that takes place will cause colour changes.
2. Place the R20C5W film in a refrigerator and observe the change in colours (from blue to red to black). Remove it from the refrigerator and observe the reverse order of colour as the temperature rises (black to red to blue). In the winter time, a window pane may also be used to cool the film.
3. Using the R25C5W, R30C5W sheets, you can determine the relative hand temperatures of a group of people. Due to variations in blood circulation, and depending on whether a person had been holding a cold glass or had been smoking a cigarette, a wide range of temperature results may be obtained in the group. Even though normal body temperature is 37°C, you will note immediately that skin temperatures fluctuate considerably from this value. Should a person not be able to cause a colour reaction on even the R25C5W, move the sheet away from the fingertips to the wrist area. You will eventually find a warmer temperature.
4. You can test an object having a simple flat surface but with a complicated internal structure, which is invisible to the eye; e.g., a honeycomb structure, a flat surface made up of different types of metal or plastic, or a flat surface having a varying thickness. Place the black side of a TLC sheet in direct contact with the surface of the object. Slowly apply heat to the other side of the object. Use a floodlight, heat gun, light bulb, heating pad, or some other suitable heat source. Heat will "flow" through the object to the surface in contact with the TLC sheet causing it to change colour. However, it will flow at different rates depending upon the different thermal conductivities of different areas. The sheet will therefore give a thermal map of the structure beneath the surface. These simple experiments are designed as an introduction to the usefulness of TLC products. The materials have many applications, not only in testing, but also in industry, medicine and the home.

Note: As with all TLC applications, the better the incident lighting, the brighter the colours reflected by the TLC. However, the use of incandescent lamps too close to the TLC sheet should be avoided, as the materials are sensitive to UV light and the colour play properties will change on prolonged exposure.

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