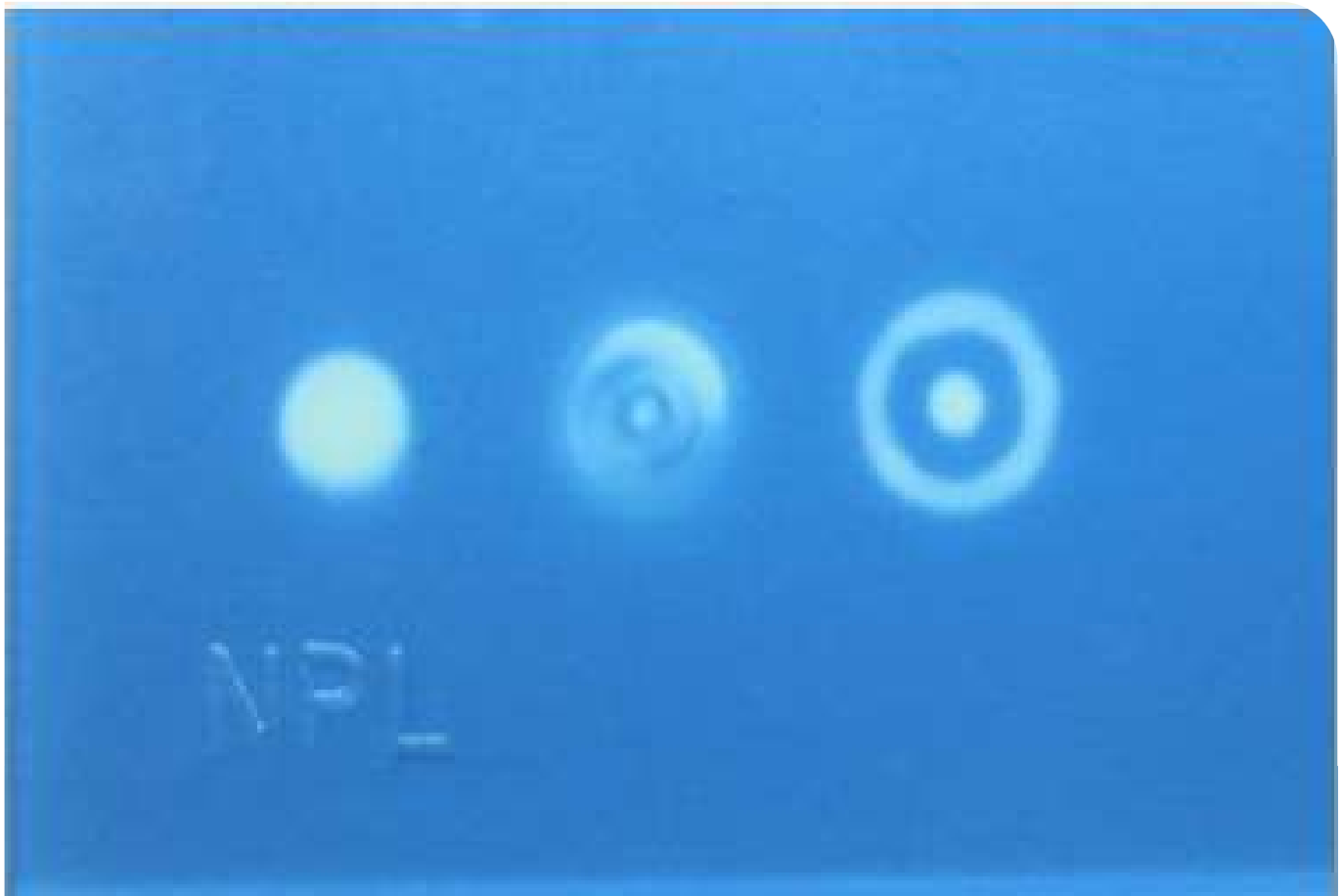


Thermochromic tile – Instructions and guidance for use with physiotherapy units



This document contains guidance for use of the Thermochromic (TC) tile. The protocol for physiotherapy ultrasound units has been provided by the United Kingdom National Physical Laboratory (London).

TYPICAL PROPERTIES

| | |
|-----------------------------|---|
| Appearance | Two-layer clear/light-blue polyurethane sheet |
| Dimensions of standard tile | 250 mm X 200 mm X 15 mm |
| Maximum exposure duration | $\frac{5 \times \text{frequency [in MHz]}}{\text{Intensity [in W cm}^{-2}\text{]}}$ |
| Resistant to | Isopropyl Alcohol (IPA) Tricholethylene |
| Affected by | Ketones (MEK, Acetone) – Swell Dichloromethane – Swell and break down |
| Avoid prolonged exposure to | Ozone UV |
| Stability | Very stable due to cross-linked nature of polymer |

Care should be taken to avoid excessive heating of the tile, otherwise a permanent colour switch, and denaturing of the plastic will occur. Therefore, it is strongly recommended that you start testing with short timed exposures, inspecting for noticeable colour changes, and gradually increasing exposure time to enhance detail. This will minimise the risk of damage to the tile. (The absorption of ultrasound in the absorber is much greater than typical in body tissue, therefore the tile may heat up faster than expected.)

It is recommended that the nominal applied exposure conditions used for testing should be an intensity value of 1 W cm^{-2} .

If f is the frequency of the unit to be tested in MHz, calculate an initial switch ON time in seconds for the exposure equal to $5 * f$. For a frequency of 3 MHz for example, the ON time will be 15 seconds.

IN USING THE TC TILE WITH A NEW PHYSIOTHERAPY ULTRASOUND UNIT, THE FOLLOWING PROCEDURE SHOULD BE FOLLOWED:

- 1) Couple the treatment head onto the TC tile using a generous amount of coupling gel. Although the treatment head can be hand held, it is sometimes better, in terms of repeatability, to weight the head down to secure it over one position of the TC tile.
- 2) Set the unit to the desired 1 W cm^{-2} setting and switch on for $5 * f$ seconds.
- 3) Remove the treatment head, wipe away the coupling gel and observe the beam pattern.

- 4) If it is too faint, then repeat the procedure again, but leaving it a little longer, perhaps increasing the exposure by 20% each time. You may wish to repeat this exposure on another part of the TC tile, whilst the original exposed area clears.
- 5) Repeat until you are happy with the profile.

If you wish to increase the physiotherapy unit Intensity setting to, for example, 2 W cm^{-2} , the ON time should be no more than $2.5 * f$, where f is again the acoustic frequency.

Following the procedure given above should ensure that you do not damage the TC tile. Damage will arise from excessive temperature rises and will appear as bubbles or discolouring at the interface between the two layers. Once damaged, that particular part of the tiles should not be re-used.

The generated beam-profile will slowly disappear as the temperature of the TC tile reverts back to room temperature, but the process can be accelerated by cooling i.e. storing the tile in a fridge.

'GHOSTING' OF PREVIOUS EXPOSURES

Over time previous exposures may leave visible impressions on the tile. If this 'ghosting' occurs the tile can be reset through submersion in a heated water bath.

The tile should be submerged for 1 hour in a bath at approximately $43 \text{ }^{\circ}\text{C}$, ensuring that the tile visibly changes colour fully and is then held in this state for a short period. The water temperature should not exceed $45 \text{ }^{\circ}\text{C}$. Cooling of the tile can then take place naturally, or more rapidly in cold water or a refrigerator.

Additional experimental findings involving the Thermochromic tiles can be found in the publication:

Butterworth et al (2012) "EXPLOITING THERMOCHROMIC MATERIALS FOR THE RAPID QUALITY ASSURANCE OF PHYSIOTHERAPY ULTRASOUND TREATMENT HEADS", Ultrasound in Med. & Biol., Vol. 38, No. 5, pp. 767–776

All data relating to the performance of the Thermochromic tile has been provided by the United Kingdom National Physical Laboratory (London).

All information is based on results gained from experience and tests, and is believed to be accurate but is given without acceptance of liability for loss or damage attributable to reliance thereon as conditions of use lie outside the control of Precision Acoustics Ltd.