

Thermochromic tile



The Thermochromic tile, developed by the United Kingdom National Physical Laboratory (London), is a two-layer, pre-cast polyurethane sheet with density and wavespeed similar to that of water. The upper layer is optically and almost acoustically transparent but is designed to trap heat. The lower layer is ultrasonically absorbent and has crystals in it that turn white when exposed to heat. The combination of properties allows the thermochromic tile to be used as a rapid visualisation tool to display the spatial distribution of acoustic intensity for ultrasonic fields incident upon it.

THIS COMBINATION OF PROPERTIES PRODUCES A MATERIAL THAT CAN BE USED IN AREAS SUCH AS:

- Rapid visualisation of transducer fields.
- In-situ QA to easily identify whether a transducer is working.
- Qualitative identification of transducer hot-spots.
- Support for students learning about ultrasonic fields.
- The system exhibits excellent chemical resistance to a wide range of media.

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	$\frac{5 \times \text{frequency [in MHz]}}{\text{Intensity [in } W \text{ cm}^{-2}\text{]}}$
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

THERMOCHROMIC TILE AND ULTRASONIC EXPOSURE

The two-layer structure of the Thermochromic tile ensures that the heat produced when ultrasonic energy is absorbed by the lower layer is effectively trapped within the material. Once the trigger temperature is reached, the thermochromic crystals turn white and the radiated field pattern is visible. This transition requires only a few seconds to complete. Over time, the trapped heat dissipates, the internal temperature drops below the activation threshold and the Thermochromic tile returns to its original colour.

The visual appearance of the ThermoChromic tile, after exposure to ultrasound is shown in Figure 1.

The three regions all correspond to a nominal intensity of 1 W cm^{-2} . Exposure conditions were (from left to right):

- 0.75 MHz – 5 seconds
- 1.5 MHz – 10 seconds
- 3 MHz – 15 seconds

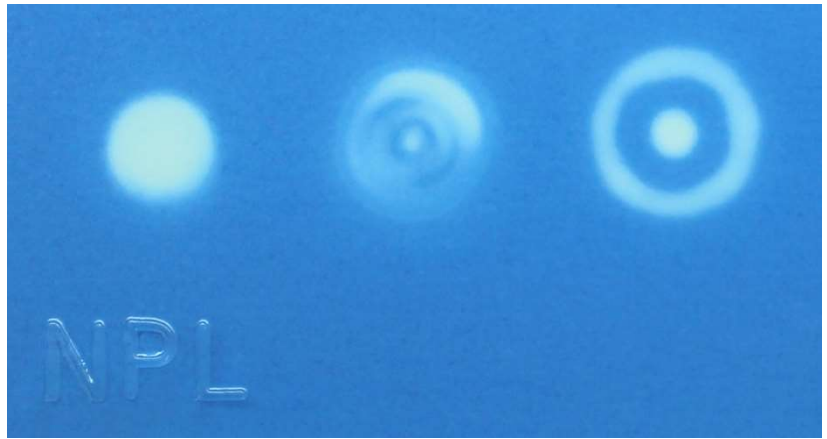


Figure 1 – Ultrasonic field patterns displayed on the ThermoChromic tile

Bajram Zeqiri, an NPL Science Fellow who led the project, describes how you would test an ultrasound treatment head with the tiles:

“In clinical practice the new ‘ThermoChromic imager’ tiles would be used in much the same way you would treat a patient: by applying coupling gel to the treatment head, coupling it to the tile, switching on for typically 10 seconds, and then removing and observing the resulting image after wiping away the gel.”

This means that the tiles can be used to quickly check for treatment head damage, asymmetric beam-patterns or ‘hot-spots’, and more simply to confirm whether the devices are working at all.

Additional guidance for use and a protocol for use with ultrasound physiotherapy units can be found in the product instructions document “ThermoChromic tile- Instructions and guidance for use with physiotherapy units”

Additional experimental findings involving the ThermoChromic tile 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).

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