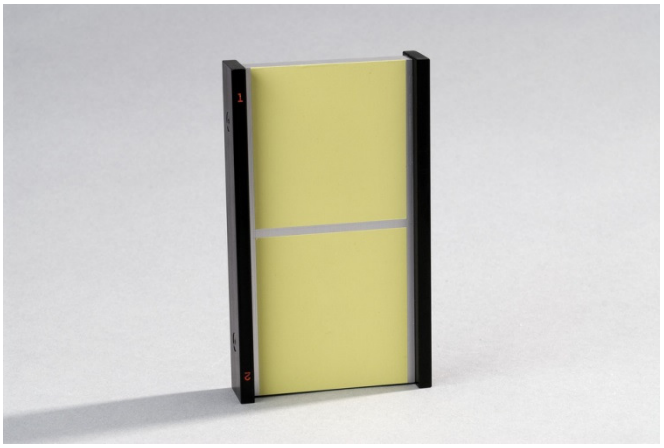
Thermal Image Plate Datasheet

Macken Instruments, Inc.

For CO_2 and Other Molecular Lasers



Displays IR Laser Beams

No longer are the firebricks and smoldering paper “tools of the trade" for researchers working with CO2, lasers. Now it's possible to see IR laser beams in real time and with high resolution using a Thermal Image Plate from Macken Instruments. The characteristics of this instrument enable to solve a wide range of problems, such as:

- The fast response time permits it to be used for viewing rapidly changing laser mode patterns when adjusting resonator mirrors.
- The convenient shape permits it to be placed next to optical elements to locate and center beams.
- The high resolution permits it to be used as a diagnostic tool to examine imperfections in IR optical elements or as an aide in optical alignment.

Even the critical adjustment of a laser interferometer is greatly simplified when the interference fringes of two misaligned beams become clearly visible.

Theory of Operation

The Thermal Image Plate displays IR laser beam through the use of thermal-sensitive phosphors. When illuminated these phosphors fluoresce by a long wavelength ultraviolet light (360nm). The intensity of the fluorescence decreases with increasing temperature. When an IR laser beam strikes the thermal-sensitive surface, the absorbed energy raises the surface temperature and produces a corresponding thermal image. The produced pattern appears as a dark image on a bright fluorescent background when the surface is illuminated by an ultraviolet light. Different sensitivity ranges are obtained by using different phosphors and by varying the amount of thermal insulation between the phosphors and the anodized aluminum heat sink. Any long wavelength, ultraviolet light can be used to illuminate the surface, but Macken Instruments' Lamp Model 22-UV Is the most satisfactory. Its small size and high-illumination level permit it to be conveniently positioned out of the working area.

Description

The power density of CO_2 laser beams ranges from those which can rapidly burn holes in firebrick to those that can't be felt on the back of the hand. Eight different surfaces with overlapping sensitivities are used to smoothly span the power density range from 200 watts/cm^2 to 0.01 watts/cm^2. (The minimum detectable power for a focused beam is less than .001 watts.) Thermal Image Plate 22-A contains four surfaces which cover the power densities commonly obtained from CO_2 laser beams as they emerge from the laser. The lower power densities usually found in optical systems and divergent beams are covered by Thermal Plate 22-B.

The physical dimensions of each Thermal Image Plate (22A and 22-B) are 6" x 3” x ½”. Each side of these plates contains two sensitive surfaces which are 3" x 3". The 22UV ultraviolet lamp measures 6" x 2" x 2".

The following table gives the specifications of the eight surfaces measured at 8 to 12 microns. For use at 4 to 8 microns, multiply columns a, b and c by 2. For use at 2 to 4 microns, multiply columns a, b and c by 2.5.

MODEL NUMBER	SURFACE NUMBER	NORMAL SENSITIVTY RANGE (a.) W/CM^2	MINIMUM POWER DENSITY (b.) W/CM^2	DAMAGE THRESHOLD (c.) W/CM^2	RESPONSE TIME (d.) SEC.	RESOLUTION (e.) LINES/IN.
	1	60-200	15	800	<0.03	>300
22A	2	30-100	8	600	<0.03	>300
	3	15-50	4	350	0.03	300
	4	7.5-25	2	200	0.03	200
	5	3.3-11	0.9	100	0.06	100
22B	6	1.5-5	0.4	44	0.15	50
	7	0.4-2.4	0.06	24	0.2	100
	8	0.06-0.4	0.01	4	1.0	16

a. The normal sensitivity range is the spread of power densities which can be easily viewed with no reduction in background illumination. The upper power density cutoff occurs when the surface becomes saturated, turning the area completely black and making it incapable of displaying any further detail within the beam.

b. The minimum-detectable power densities are the lowest power densities observable under the most favorable illumination levels. For this sensitivity the room lights must be dimmed and the level of ultraviolet Illumination decreased to produce a dim fluorescence.

c. Damage threshold is the power density which produces a permanent change in the thermal-sensitive surface. This occurs at power factors at least four times greater than saturation. Therefore, when saturation occurs, a lower sensitivity surface should be used to display the beam.

d. The response time is the length of time it takes a change in the beam to be displayed as a change in the thermal image.

e. The resolution of a surface is the maximum number of dark and light line pairs which can be displayed with good contrast. For comparison, the resolution of a newspaper photographic is approximately 70 lines/inch. Two 002 laser beams intersecting at an angle of two degrees produce an 80 line/inch interference pattern.

Power Dissipation

A Thermal Image Plate is capable of displaying beams up to 200 watts. However, it must be removed from the beam and allowed to cool when there is a marked decrease in overall fluorescence. This occurs when the plate has absorbed 15,000 watt seconds of power. Powers less than 30 watts can be dissipated indefinitely.

Safety

Precautions have been taken to eliminate specular reflections from the Thermal Image Plate. Both the thermal-sensitive surfaces and the anodized aluminum have matte finishes and show little surface reflection at 10.6 microns. However, standard safety precautions such as wearing protective glasses should always be observed when working with IR lasers.

Thermal Image Plate User Instructions

Macken Instruments, Inc. *For CO_2 and Other Molecular Lasers*

22A & 22B Operating Instructions:

1. Illuminate the surface of the Thermal Image Plate with Model 22-UV Ultraviolet Light or equivalent to' produce a uniform fluorescence. Stand the UV lamp on end and place it 6" to 9" from the surface.
2. Permit the laser beam to strike the fluorescing surface. When working with a beam of an unknown power density, start with the least sensitive surface until the darkened image of the beam is obtained.
3. Avoid power densities in excess of those which cause a portion of the image to saturate (complete loss of fluorescence). When a significant part of the beam appears black on the fluorescent plate, one is approaching the power density which can damage the surface. At this point, a less sensitive surface should be used.
4. Do not pass the plate through the focus of a laser beam unless the total power is less than 0.04 watts.
5. To increase the sensitivity of any surface, decrease the level of UV illumination to produce a dim fluorescence and, if necessary, dim the room lights.
6. Keep the Thermal Image Plates in their case when not in use. Remove UV illumination when it is not necessary. Avoid exposing plates to direct sunlight for prolonged periods.

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Positioning:
The Thermal Image Plate is designed to be visible without the need of darkening the room lights. However, the contrast and brilliance can be improved if it is positioned in a shadow or facing a darker portion of 'the room.

High-Sensitivity Surfaces:
Surfaces #7 and #8 are made from a single rubber membrane with differing amounts of thermal insulation for the two halves of the plate. Care should be taken to avoid physical damage to the surface. However, the tension of the membrane is not sufficient to cause a tear if a puncture should occur. If necessary, this membrane can be replaced.

Tuning a Laser:
Often, it is convenient to use the Thermal Image Plate to tune up a laser. If a large increase in power is expected when the mirrors are properly aligned, there is danger of damaging the thermal sensitive surface unless' precautions are taken. The least sensitive surface capable of displaying the beam should be used and the mirrors should be adjusted slowly. Progressively less sensitive, surfaces should be used as the power increases.

Cleaning:
Then Thermal Image surfaces are delicate. They should always be treated with care. Even touching the surface might leave dirt in the matte surface which would require cleaning. The surfaces may be cleaned using a cotton applicator or soft tissue freshly dampened with acetone. Cleaning should be done with light smooth strokes. Since there is some slight degradation of the surface with each cleaning, frequent cleanings should be avoided. Never clean the surface with water, since this degrades an invisible coating on the surface.

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For use with lasers emitting at other wavelengths, tests should be made by the user to determine the appropriate safety precautions. The laser beam should never be allowed to strike the ultraviolet lamp or its cord.

The ultraviolet radiation from Model 22-UV Lamp is not harmful. If other UV lamps are used, they should only emit "long wave" ultraviolet.

Additional information about the characteristics of the surfaces is contained in the Thermal Image data sheet.

Photographs:
If photographs are to be made of the patterns displayed on a Thermal Image Plate, a K2 filter (or equivalent) should be used to eliminate any reflected UV radiation.