APPLICATION NOTE

SPI Supplies
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Use of ITO in heating applications

Required power

It is impossible to exactly calculate the power required to heat a surface to a given temperature without using a complicated model involving heat loss by conduction, radiation and convection. We can however make a reasonable estimate where the conductive losses are small and the heated surface is less than 100°C above its surroundings.

The thermal impedance of a typical air layer is 0.12 Km2/W. If the air layer is moving this drops to 0.05 K.m2/W. If a liquid is touching one side of the heater, then the thermal impedance to the liquid will be even lower and we'll have to allow for heating the entire volume of liquid (not covered here).

So taking a heater in air, the heat flow across each air layer will be:

$$Heat\ Flow\ (Watts) = \frac{Area\ \mathrm{X}\ \Delta\mathrm{T}}{Impedance}$$

where ΔT = temperature difference from heated surface to surroundings

So if we have, for example, a glass microscope slide to heat to 50°C in an ambient of 25°C. The area per side is 25mm x 75mm = 0.025m x 0.075m = 1.9 x 10–3 m2. It will lose heat from both sides, so the estimated heat loss will be:

$$= \frac{(2 \times 1.9 \times 10^{-3}) \times (50 - 25)}{0.12}$$

$$= \frac{3.8 \times 10^{-3} \times 25}{0.12}$$

$$= 0.8\ W$$

It is usually sensible to leave a margin for error (as this is an estimate and also conditions may change).

So allowing a 50% safety margin we have a final value of 1.2W.

Electrical requirements

To deliver the required power we will pass a current (I) through the transparent heater by applying a voltage V. If the heater has a resistance of R, the current flow will be:

$I = \frac{V}{R}$ (Ohm's Law)

The power delivered will be V^2/R. We will usually need to keep the voltage low for safety reasons (please check your appropriate legal safety directives).

To continue our glass slide example from above, if we want to use 10V maximum and we want 1.2W then the heater will need a resistance R so that:

$$1.2 = \frac{10^2}{R}$$

that is

$$R = \frac{10^2}{1.2} = 83\ Ohms$$

This resistance is what we require between our bus bars. So what sheet resistance SPI Supplies ITO coating do we need to specify?

SPI Supplies ITO sheet resistance

The SPI Supplies ITO sheet resistance required to give 80 Ohms between the bus bars will depend on the shape of the heater and where we put the bus bars.

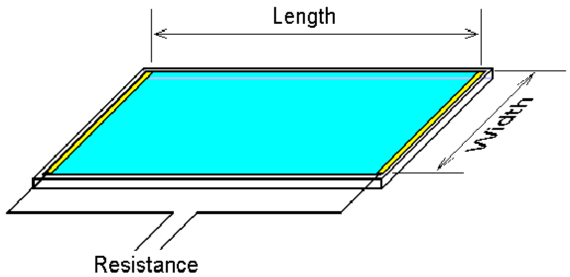

Figure 1: Sheet resistance measurement

Resistance (Ohms) = sheet resistance (Ohms/square) x width / length

To finish our example we calculate the two possibilities on our example glass slide. If we put the bus bars at the ends of the slide then it is approximately 75mm between the bus bars and they are 25mm long. So we have conduction across 3 squares (as 75/25 = 3). We want 80 Ohms total, so the required sheet resistance is 80/3 = 27 Ohms/square. A lower resistance gives a higher power, so to use a standard SPI Supplies ITO product we should specify 20 Ohms/square.

We could apply the bus bars along the long side of our glass slide. This would produce current flow across 0.3 of a square (25/75). The sheet resistance required in this instance would then be 80/0.3 = 270 Ohms/square. This would need to be a special order since the largest stock resistance is 100 Ohms.

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