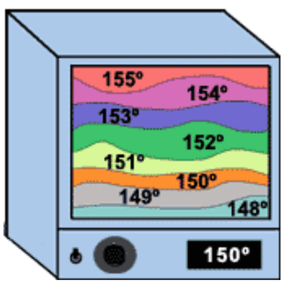
Hot Plate Overview:

Hotplates have several advantages over convection type ovens:

- decreased bake time
- increased reproducibility
- better film quality.

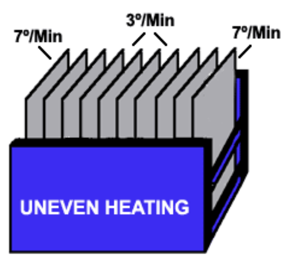
This section will describe these differences and set a few guidelines for using hotplates.

Conventional Ovens



Stratification, the formation of different temperature zones, is a problem associated with convection ovens and can severely affect film quality and reproducibility.

The heating rate of a substrate in an oven depends not only on the heated air flow past a substrate but also on its proximity to other cold substrates. Thus the heating rate for each substrate in a cassette of substrates that are being baked, will be less than if each substrate is baked alone.



In addition, substrates near the ends of a cassette heat faster than the substrates in the middle, thus producing a non-uniform heating.

Particle generation also occurs within a standard oven. In a forced-air, convection oven, substrates are commonly exposed to a flow of particle laden air for at least 30 minutes.

During resin film cures, the substrates will be exposed to considerable particulate contamination. The substrates are vulnerable since the film may still contain solvents and during this 'soft' state, the film is very susceptible to having particles adhere to it

The Skin Effect

Another disadvantage in normal oven baking results from baking substrates from the "outside in". Since heat is applied to the outer surface of the film first, a skin forms on the surface of the film thus trapping solvents. Upon vaporizing, these solvents form blisters or bubbles which results in adhesion loss or even bulk film failure. This problem prevails in processes involving thick film resins, e.g. polyimides.

No skin effect occurs on a hotplate since hotplate baking heats the substrate from the bottom up. This "inside out" approach offers advantages for thick films since solvents in the film nearest the substrate are baked off before the film surface seals over.

Baking Uniformity

A well designed hotplate insures uniform baking across the substrate. Since the substrate intimately contacts a surface of a known constant temperature, it heats at a rate dependent only on the bake style selected and the thermal properties of the substrate.

Increased throughput results from a faster warmup of the substrate. Bake times will be measured in seconds, rather than minutes or hours, as in conventional ovens.

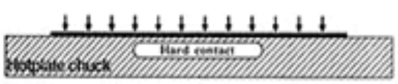
Reduced vulnerability to particulate contamination is a major advantage of hotplate baking. Only conditioned ambient clean room air passes over the substrate.

Baking Styles -*Three bake styles exist Hot Plates: proximity bake, soft contact bake and hard contact bake. These may be used in combination to further refine your baking process. The following section will discuss these methods and the advantages of each.*

PROXIMITY BAKE

In this method, substrates float on a pillow of nitrogen that is blown through orifices in the chuck surface. A combination of heated gas and radiant heat from the chuck heats the substrate. This slower heating of the substrate reduces blistering and cracking of films incorporating fast-drying solvents.

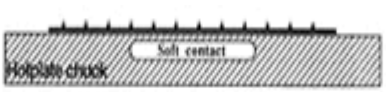
Commonly used as a pre-bake stage and / or in combination with the hard-contact bake, the proximity bake makes two temperature bake schedules obsolete.



HARD-CONTACT BAKE

Hard-contact bake represents the most accurate baking method for hotplates. Vacuum ports in the chuck hold the substrate securely in place. This method insures bake uniformity and minimizes bowing and warping of the substrate.

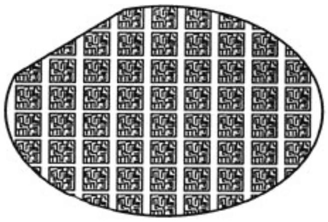
A quicker warm-up and more efficient heating produces faster throughput in shorter bake times. Selecting the "VAC" (vacuum bake) method initiates the hard-contact bake cycle-the preferred bake method.



SOFT-CONTACT BAKE

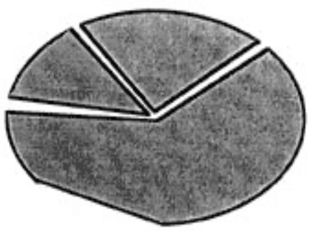
gravity alone holds the substrate against the surface of the chuck. While this represents the least accurate bake style, this method finds some use as an intermediate style, between the hard-contact and the proximity bakes, as a multiple step warm-up.

Silicon Wafers



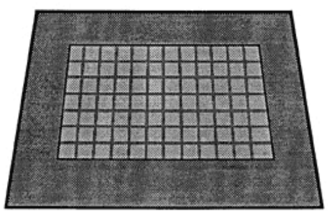
IOT Pal Hot Plates virtually eliminate the skin effect with thick films and substantially increase throughput. The chart below presents process examples for two commonly used resins: positive photoresist and polyimide. These figures should not be use as a rigid guideline since the best method with a particular baking application can only be achieved through experimentation.

Galium Arsinide



Segments and pieces of GaAs wafers are commonly used in research and pilot lines for economic reasons. The IOT Pal Hot Plates are ideally suited for these circumstances as all IOT Pal Hot Plates offer the proximity bake mode. This is most useful for pre-warming GaAs wafers before going to a hard-contact bake and insures uniform heating without thermal shock. Typical bake processes are identical to those provided above, for silicon substrates.

Photomasks and Displays



Reproducibility and throughput are key issues both for photomasks and for display makers. Because of the large thermal mass of these substrates, oven baking is slow and non-uniform. A proximity bake eliminates back side defects.   Reproducibility is greatly improved since the rate of heating is not dependent on batch size. All substrates are baked individually.