

**WHY THIN FILM?** The performance differences between thin and thick film are important to know.

1. *Extremely stable (low TCR)*
2. *Low Noise (parasitic capacitance and resistance)*
3. *Excellent High Frequency Performance*
4. *High Accuracy (tight tolerances)*

The basic distinction between thick film and thin film is the method of deposition of the metallization. In thick film, specially formulated pastes are applied and fired onto a substrate. The pastes are usually applied with a silk screen method and the substrate is of 96% alumina ceramic. In thin film, a layer of metallization is sputtered onto a substrate and then a pattern is etched into the previously applied metal layer, the substrates are often 99.5% alumina ceramic, silicon, or glass. Thick film is an additive process where layers of termination and resistor material are added to the substrate, while thin film is a subtractive process where the unwanted material is etched away in succession of selective photoetching processes. The use of photo-lithographic processes to form thin film patterns produce much finer lines and traces than thick film processes. Thin film is very appropriate for higher density and high frequency applications.

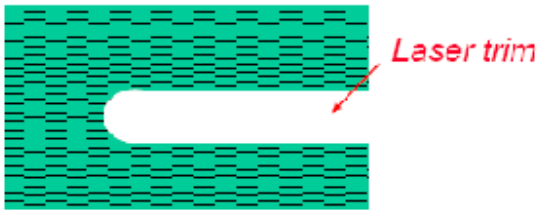
Thick and thin film technologies are well suited for low to medium volume custom circuits. Thick film has the advantages of lower cost (both of tooling up new designs and of production runs), of being able to handle more power, and of being able to service a higher range of ohmic values. Thin film has the advantages of tighter absolute and ratio tolerances and more environmentally stable components with lower noise and tighter TCR than thick film.

Thin film technology is used wherever precision resistors are needed. <http://www.bourns.com/pdfs/thinfilm.pdf>

### Thin Film

#### Process characteristics

- Trimming in material with good heat conduction

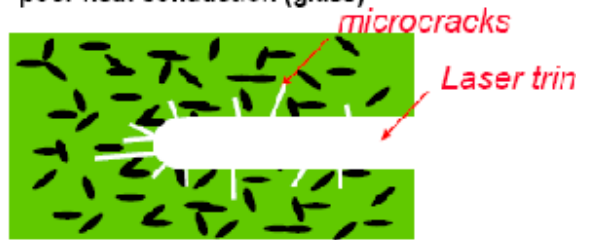


#### Product characteristics

- Low TCR, high lifetime stability
- low noise

### Thick Film

- Trimming in material with poor heat conduction (glass)

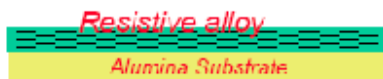


- Standard TCR, lifetime stability
- Higher noise

### Thin Film

#### Process characteristics

- Homogeneous films

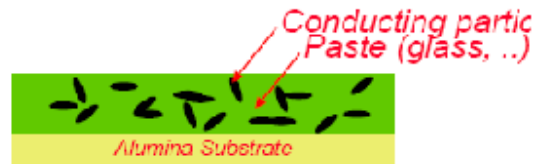


#### Product characteristics

- Low TCR, high lifetime stability
- low parasitics
- HF stable, low noise

### Thick Film

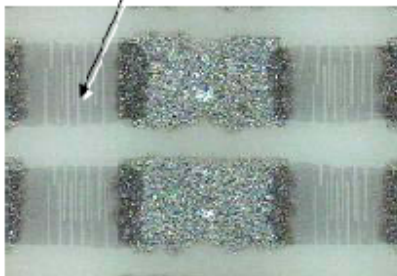
- Grain containing paste



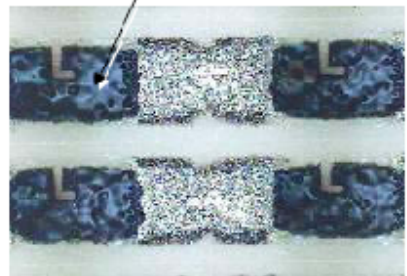
- Standard TCR, lifetime stability
- Higher parasitics
- Parallel resonance's, high noise

## After Laser Trimming Process

Thin film pattern



Thick film pattern



Thin film chip resistors are manufactured using proprietary versions of TaNx as resistive material. Via a sputtering process, a very thin metallic film is deposited on a substrate under vacuum conditions. The deposited film is continuous and defect free conferring stability, very low TCR, very low current noise and negligible non-linearity.

In contrast, thick film resistors normally use resistance metal oxides with glass-based materials to form a paste for printing on the substrate. After burning off the solvents and after few other heat treatments the glass filled resistive material has a sponge like structure with random inclusions and defects. These films will absorb gases and moisture (if not hermetically sealed) causing drifts and long term instability. The random defects are an obvious source of noise and detrimentally affect the temperature coefficient of resistance, TCR.

Both thin film and thick film resistors use laser trimming to adjust the resistance value during final steps of the manufacturing process. However, the heat generated during laser trimming causes micro-cracks on a thick film resistor and therefore affects the short term and long term stability. Thin film resistors need less laser power than that needed for thick film resistor. Thin film resistors do not exhibit micro-cracking during laser trimming. Consequently thin film resistors show superior stability and noise performance.

Conclusion: Thin film resistors are the preferred material for all microwave passive and active power components like microwave power resistors, microwave power terminations, microwave resistive power dividers, microwave power attenuators.

[http://www.usmicrowaves.com/appnotes/  
thin\\_film\\_resistors\\_versus\\_thick\\_film\\_resistors\\_how\\_they\\_compare\\_usm\\_app\\_note110.htm](http://www.usmicrowaves.com/appnotes/thin_film_resistors_versus_thick_film_resistors_how_they_compare_usm_app_note110.htm)

	Standard Precision	Normal min. TCR (ppm/C)	Stability	High Frequency Characteristics	Current Noise	3rd Harmonic Stress (non-linearity)
Thin Film	±0.1% ±0.5%	±25	Excellent	Excellent	Excellent	Excellent
Thick Film	±1% ±5%	±100~250	Fair	Good	Fair	Good

	Item Size	Resistance to Soldering Heat	Short Time Overload	Bending	Rapid Charge of Temperature	Damp Heat
Thin Film	All size	±0.5%+0.05R	±0.5%+0.05R	±0.5%+0.05R	±0.5%+0.05R	±0.5%+0.05R
Thick Film	1206-0603	±1%+0.05R	±2%+0.05R	±1%+0.05R	±1%+0.05R	R<1MR±1.5%+0.1R R<1MR±3.0%+0.1R
	0402	±1.0%+0.05R	±2.0%+0.05R	±1.0%+0.05R	±2.0%+0.05R	±3.0%+0.1R