I was recently asked a few questions on SMT chip resistors.

What is the difference between thick and thin film resistors?

How thick is a thick film resistor?

Let’s first discuss what is the thickness of a “thick film” versus a “thin film”. A traditional dimensional, dividing line has been ~5μm (~0.2 mils or ~50,000Å Angstroms). Thick films are typically 10-50 μm thick and thin films are from 10 nm-2 μm in thickness. However, a more functional definition, based on the resistor fabrication technique, is described below.

**Thick film** resistors (Figure 1) are fabricated with an additive process where conductive; dielectrics, and resistive materials are “silk screened” with a pattern onto an alumina ceramic substrate. Electrodes are deposited with a conductive material and fired into the ceramic at about 850°C. Next the resistive film is deposited and fired. The resistor is designed on the low side (~ -20%) so that laser cuts during trimming will increase the resistance and bring it into value. The resistor is then coated, and metalized on its edges and plated.

**Thin film** (or **metal film**) (Figure 2) resistors are fabricated with a subtractive process where conductive, insulative, and resistive materials are vacuum deposited and selectively etched with a photographic pattern onto an alumina ceramic substrate. The resistor is then laser trimmed (Figure 3), coated, and metalized on its edges and plated.
The electrical attributes of some of the common resistor fabrication technologies are shown in Table I below.

Table I Resistor Fabrication Technology versus Electrical Characteristics,
As a result, thick film resistors are generally cheaper than their thin film counterparts, but the tolerance and temperature coefficients one can get out of thin film resistors are generally better. Depending on the materials used, there is plenty of overlap between the two, but all things equal, thin film offer better performance for a cost premium.”

<table>
<thead>
<tr>
<th>Technology</th>
<th>Temperature Coefficient of Resistance (TCR) -55°C to +125°C Ref.</th>
<th>Initial Tolerance</th>
<th>End of Life Tolerance</th>
<th>Lead Life Stability at +70°C, Rated Power 2000 Hours and 10,000 Hours</th>
<th>ESD (V)</th>
<th>Thermal Stabilization</th>
<th>Noise (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Metal Foil</td>
<td>0.2 ppm/C</td>
<td>From 0.05%</td>
<td>&lt; 0.05%</td>
<td>0.005% (50 ppm) 0.01% (100 ppm)</td>
<td>25,000</td>
<td>&lt;1 Second</td>
<td>-42</td>
</tr>
<tr>
<td>Hgh Precision Thin Film</td>
<td>5 ppm/C</td>
<td>From 0.05%</td>
<td>&lt; 0.4%</td>
<td>0.05% (500 ppm) 0.15% (1500 ppm)</td>
<td>2500</td>
<td>&gt; few minutes</td>
<td>-20</td>
</tr>
<tr>
<td>Precision Thick Film</td>
<td>50 ppm/C</td>
<td>From 0.5%</td>
<td>&lt; 5%</td>
<td>0.3% (20,000 ppm) 2% (20,000 ppm)</td>
<td>2000</td>
<td>&gt; few minutes</td>
<td>+20</td>
</tr>
<tr>
<td>Wirewound</td>
<td>3 ppm/C</td>
<td>From 0.06%</td>
<td>&lt; 0.05%</td>
<td>0.05% (500 ppm) 0.15% (1500 ppm)</td>
<td>5000</td>
<td>&gt; few minutes</td>
<td>-35</td>
</tr>
</tbody>
</table>

References

1 Wise Geek, What are the Origins of the Phrase "Through Thick and Thin"?

2 Mil-Std-883 TM 2010 paragraph 3f 38 & 39

3 Wikipedia Angstrom

4 Questech AN009-Thick and thin film Resistor trimming Application note

5 “Strengths and weaknesses of common resistor types” Yuval Hernik, Vishay Intertechnology 5/31/2010

6 “Difference between thin film and thick-film precision surface mount resistors” electronics.stackexchange

For Further Reading

PANASONIC SURFACE MOUNT RESISTORS TECHNICAL GUIDE
Selecting the best resistor technology for the application  Yuval Hernik, Director Application Engineering, Vishay Precision Group (VPG) - December 17, 2012 EDN Blog

The Electronics Handbook, Second Edition section 2.1 Resistive elements
Edited by Jerry C. Whitaker  CRC Press, Apr 27, 2005

Resistor Links on my web site