

CARTS 2006

Photo Patterning Resistors

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Introduction

Ohmcraft's mission – to increase the performance and reliability of component products by providing fine line patterning solutions

Ohmcraft's success is based on the ability to produce fine lines with thick film resistor ink

We now have three approaches

Screen printing to 6 mil line width

MicroPen[®] to 4 mil

Photo patterning to 1 mil

Thick Film Materials

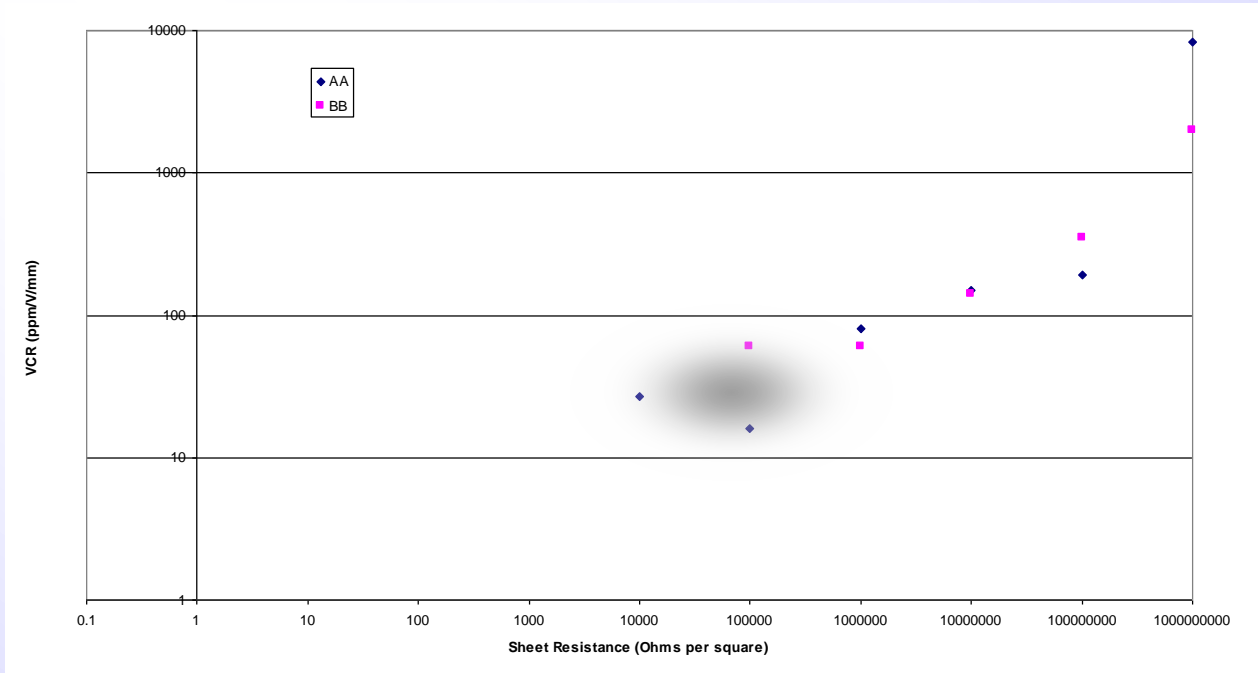
DuPont Microcircuit Materials
Research Triangle Park,
North Carolina 27709
USA
Tel: 800-284-3382

Metech, Inc.
A Company of Lord Corporation
4110 Conestoga Rd.
P.O. Box 150
Elverson, PA 19520
601-286-0420
www.metechink.com

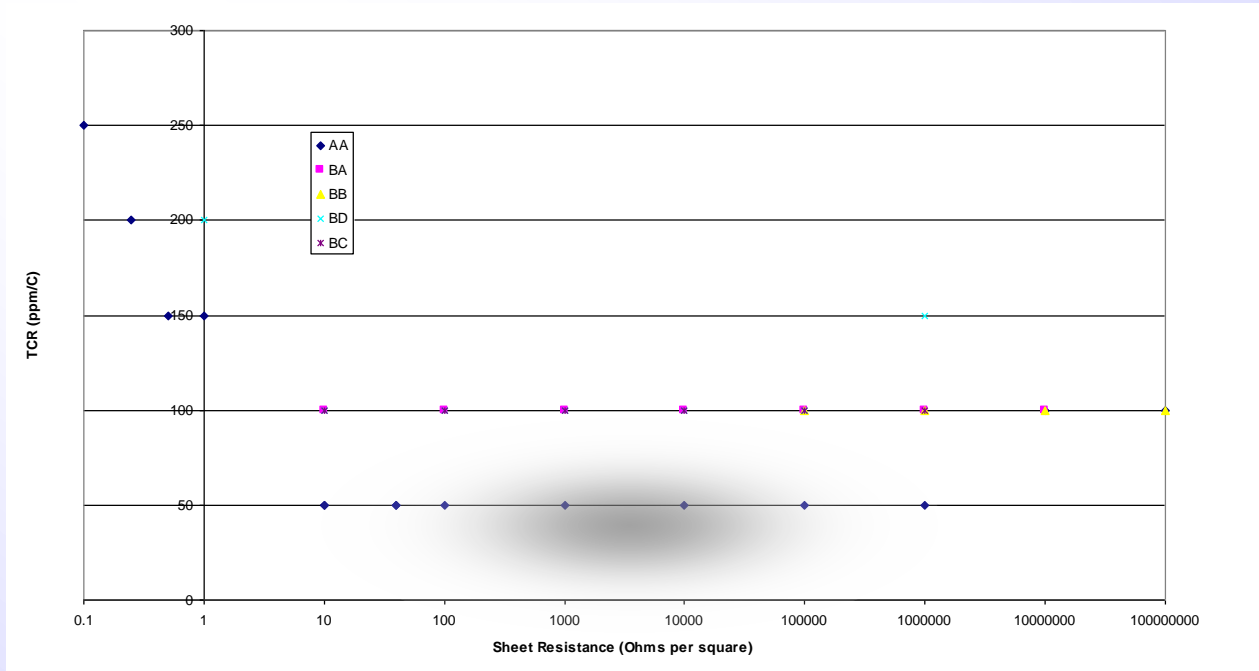
Kamaya Inc.
6407 Cross Creek Blvd,
Fort Wayne, IN 46818
Tel: 260-489-1533
E-mail: mpriebing@kamaya.com

Heraeus Inc.
Circuit Materials Division
24 Union Hill Road
West Conshohocken, PA 19428
Tel: 610-825-6050
www.4cmd.com

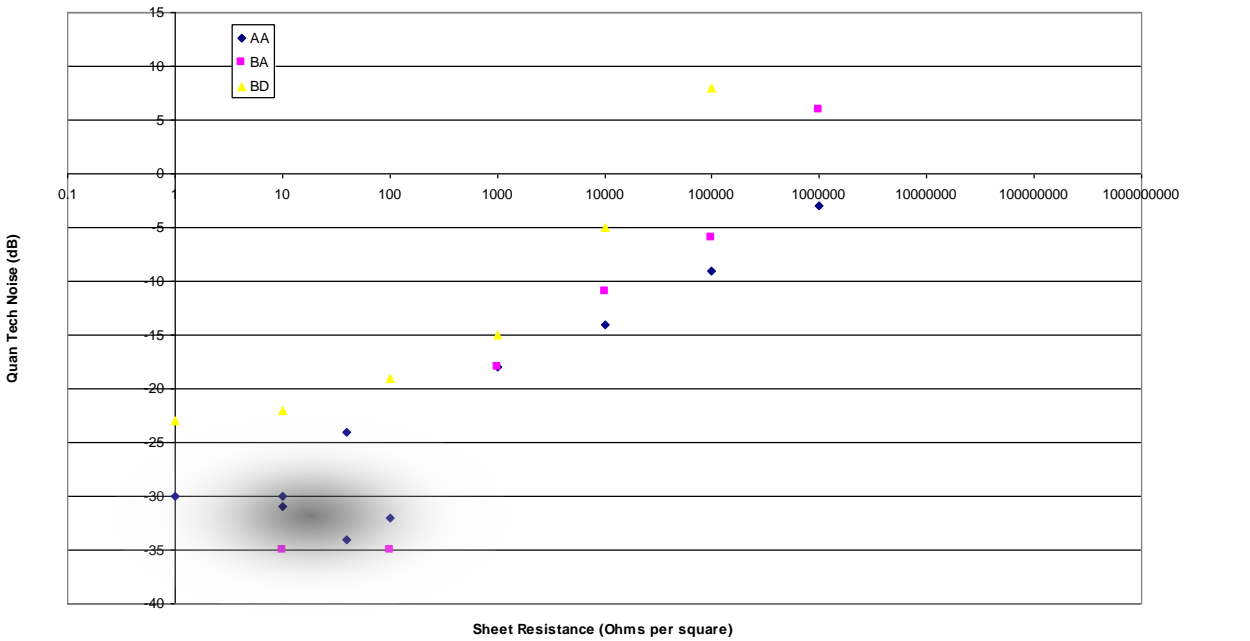
VCR



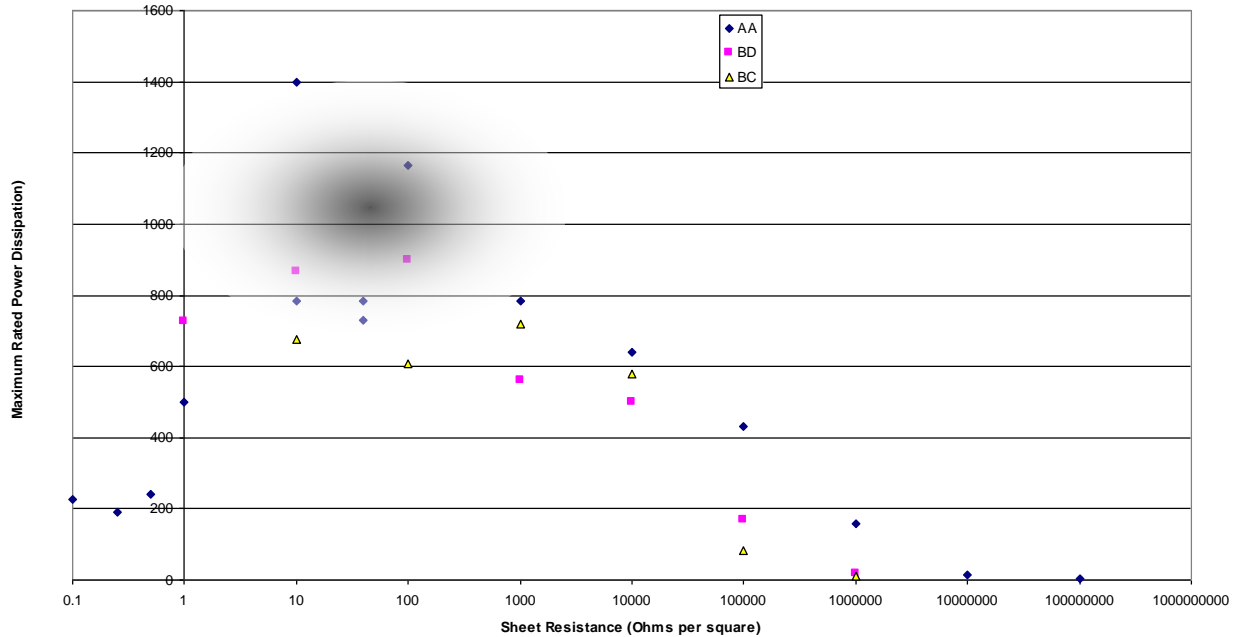
TCR



Noise



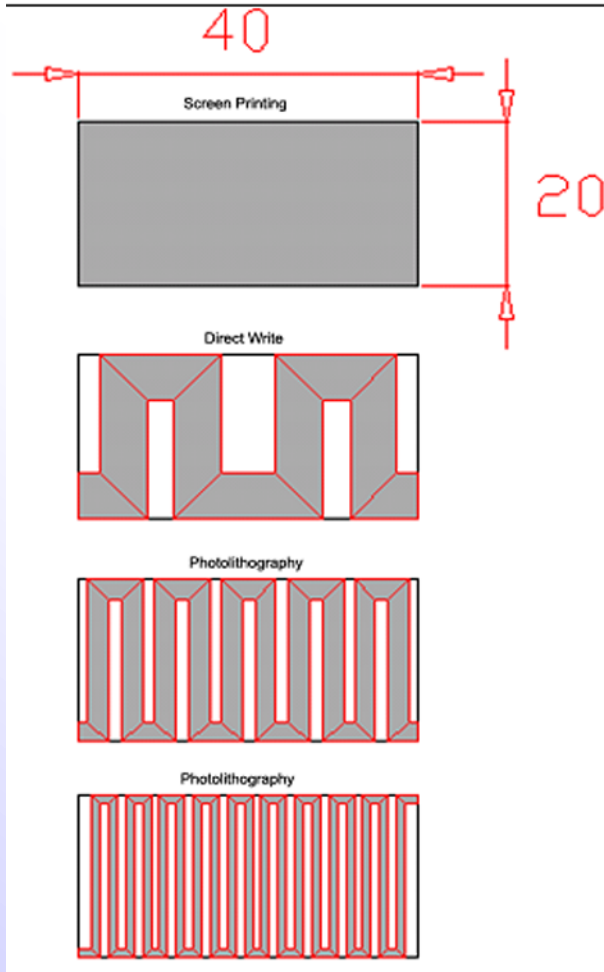
Power Handling



Benefits of Serpentine

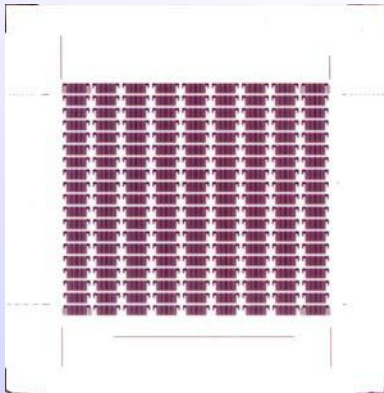
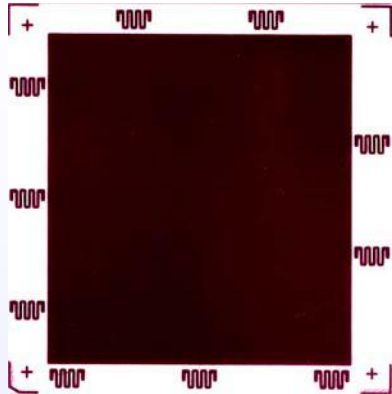
To make a 20 by 40 mil resistor with a value of 1 G Ohm

Metech 9000 series ink
(published characteristics)



Line width mil	Aspect Ratio	Ink resistivity Ohm/Square	TCR ppm	VCR ppm
20	2	5.00E+08	300	-1270
5.5	17.8	5.62E+07	90	-39
2.5	86	1.16E+07	80	-15
1	401	2.49E+06	50	-5

Photo Patterning



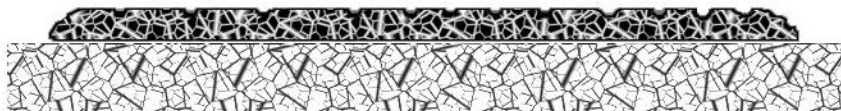
Method for fabrication:

1. Prepare substrate, typically 99.6% Alumina
2. Apply uniform thickness of thick film resistor ink, typically by screen printing
3. Dry and fire the ink appropriately
4. Apply, dry, expose, bake and develop the photoresist imagewise
5. Etch the ink, using an appropriate etchant, such as Hydrofluoric Acid, accompanied by a directed stream of rinsing agent, such as deionized water
6. Clean the etched plate with an appropriate surfactant, such as LiquiNox, to remove the residual powders
7. Strip the resist using an appropriate stripping solution
8. Create electrical contact pads, preferably using conventional thin film techniques

Photo Patterning



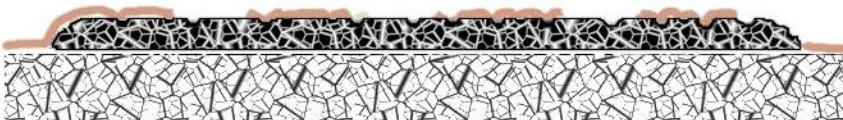
clean substrate



apply large area
of uniform thickness
thick film resistor

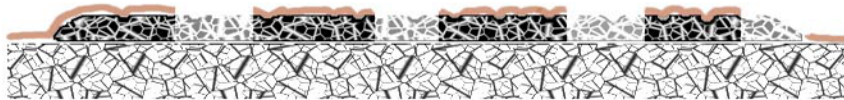


apply photoresist to
surface of plate,
bake and expose

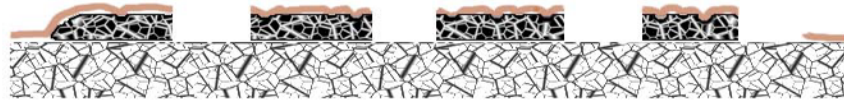


develop image
and hard bake
photoresist

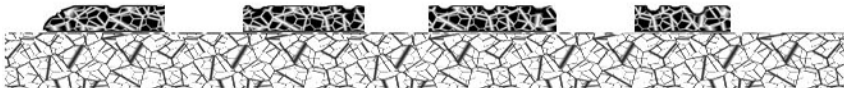
Photo Patterning



Etch glass binder



mechanically
remove resistive
particles

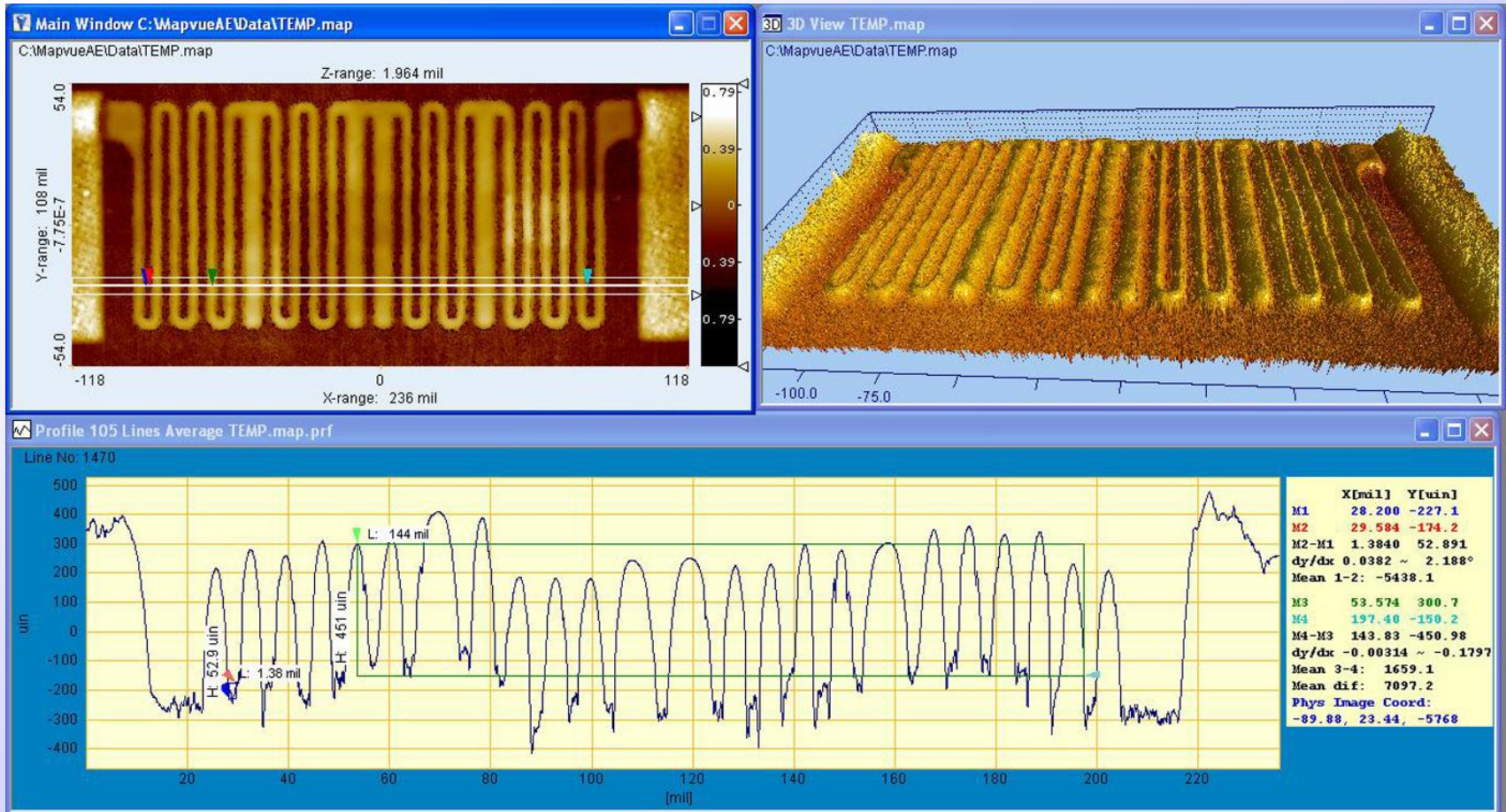


Strip photo resist

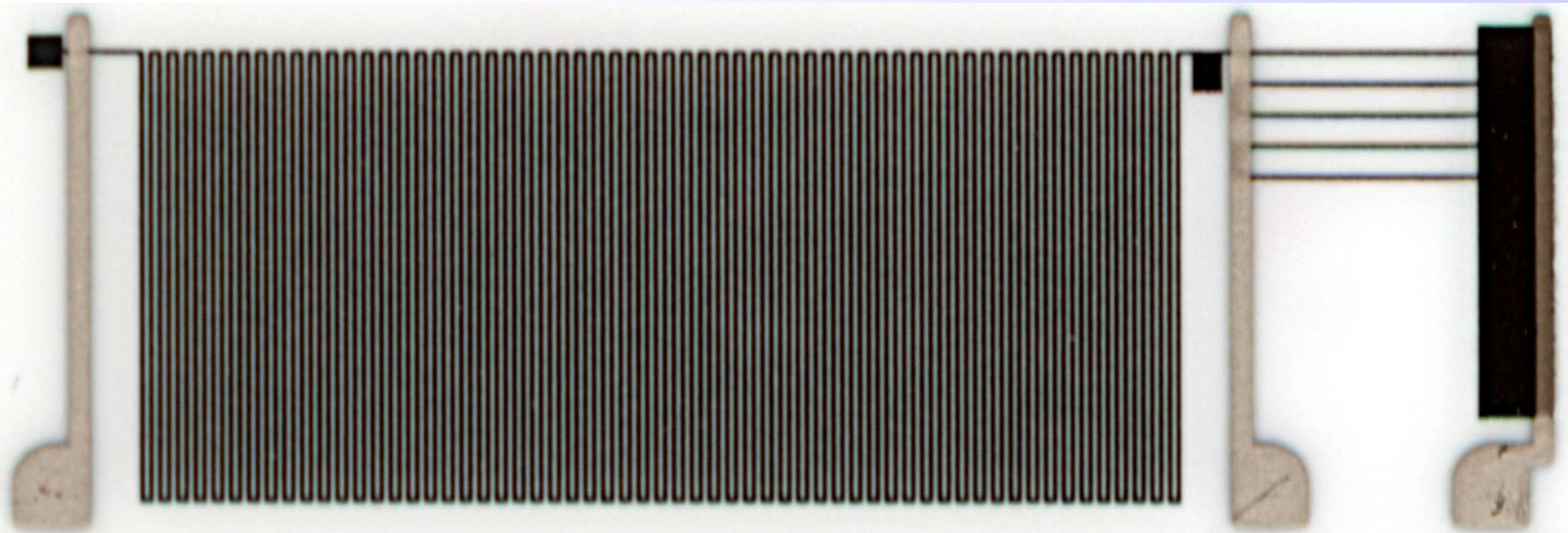


apply conductor

875 Mega Ohm



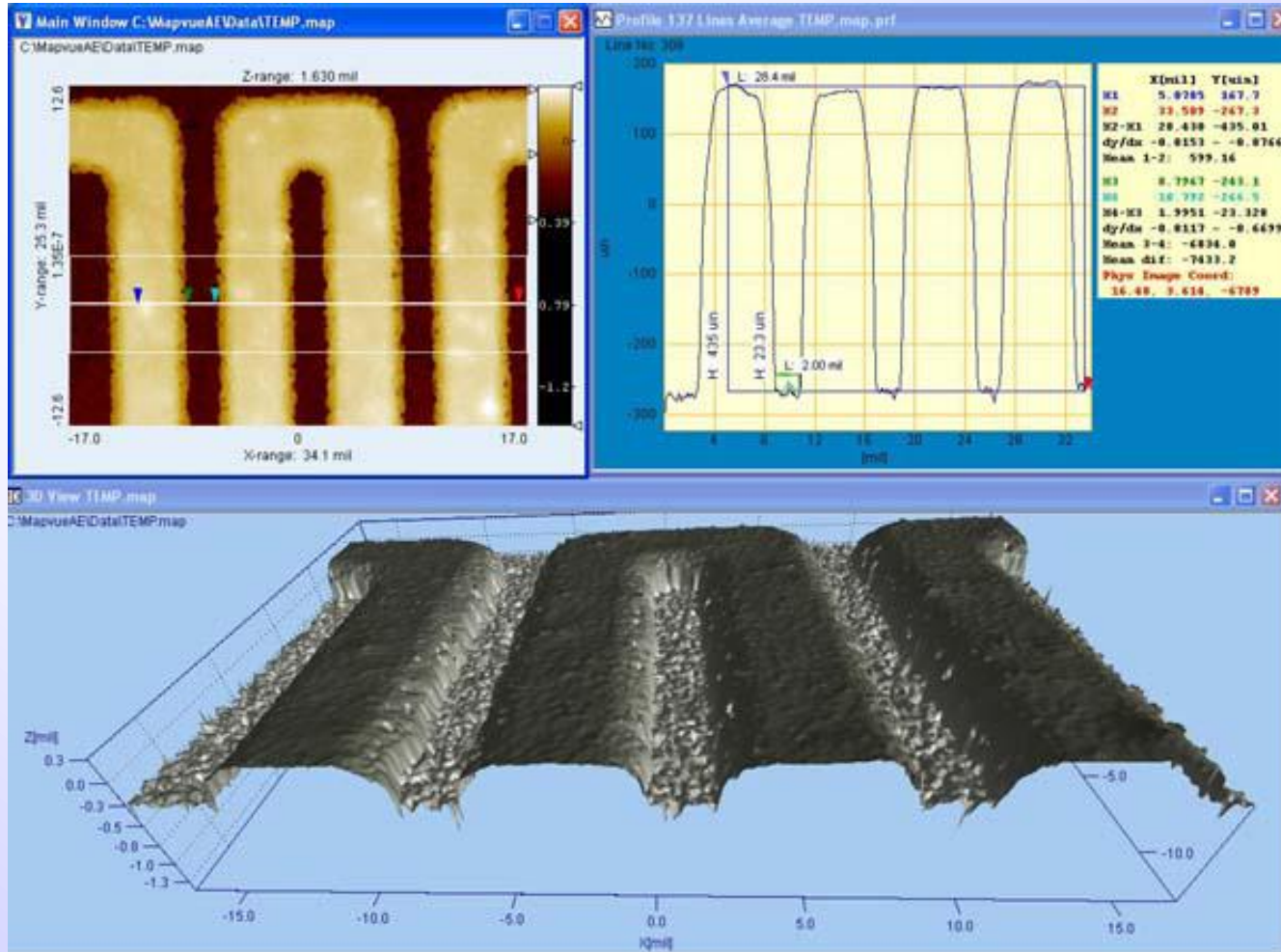
1 Giga Ohm Divider



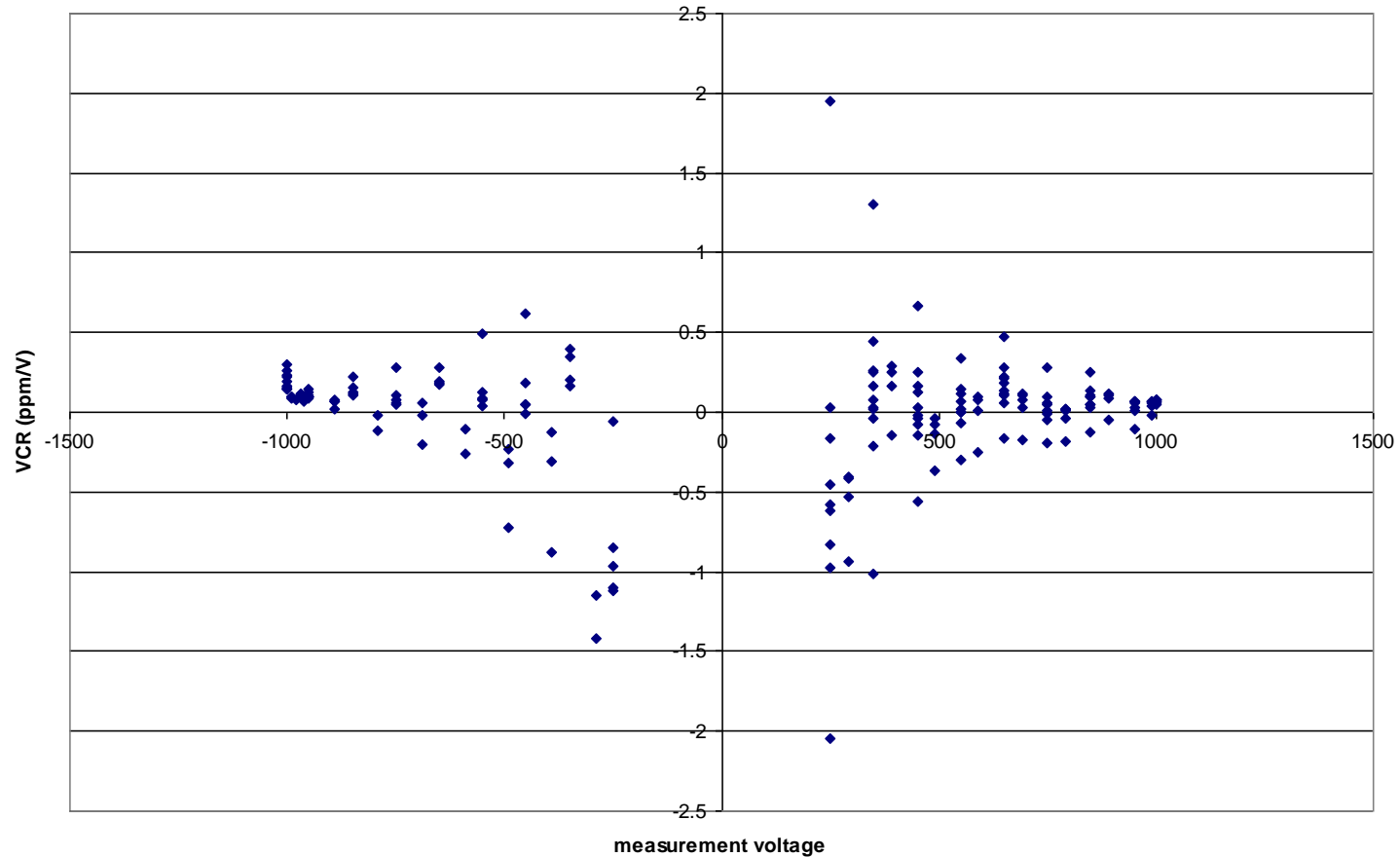
It was possible to achieve this goal with a 4 mil line with 2 mil white space gap between lines. The 48.35 inches of serpentine result in an aspect ratio of 12000, this allowed us to use an ink with a sheet resistance of 100K Ohms / square.

We were interested to know the manufacturability of a large area device with narrow white spaces. The device was manufactured on 96% Alumina, to exacerbate any difficulties with line broadening while firing the thick film conductor. The conductor is applied after patterning the resistor, in our current process.

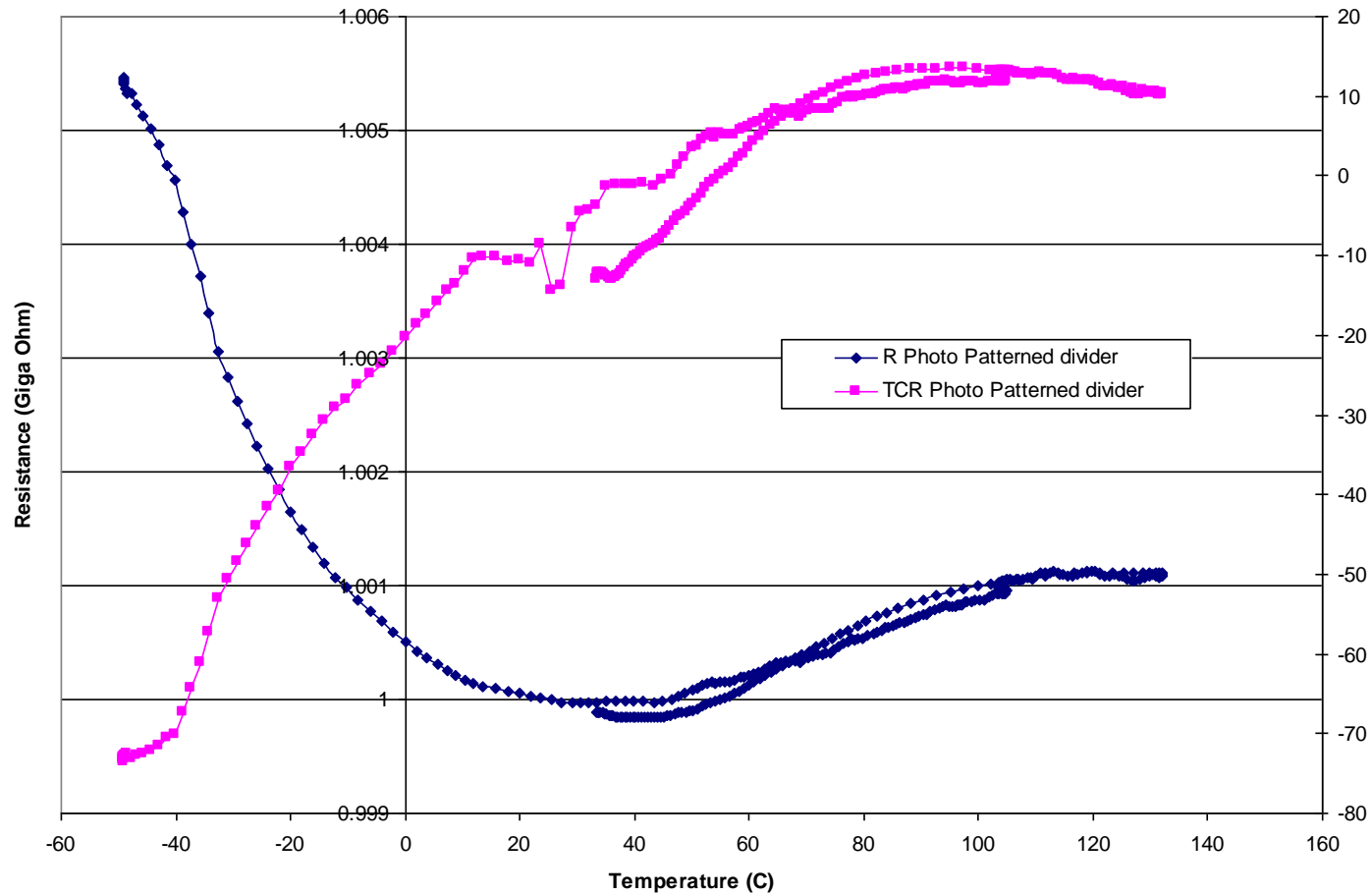
1 Giga Ohm Divider



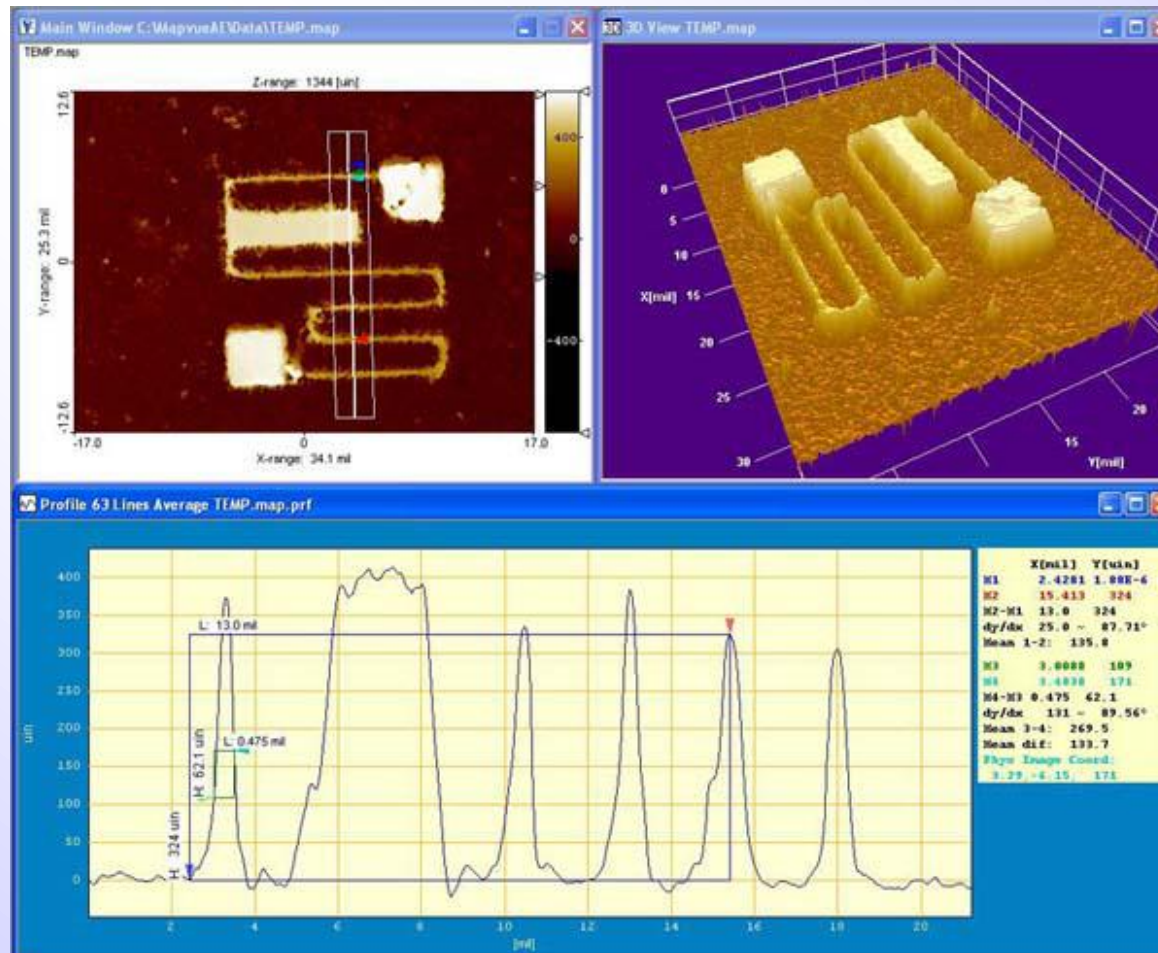
1 Giga Ohm Divider VCR



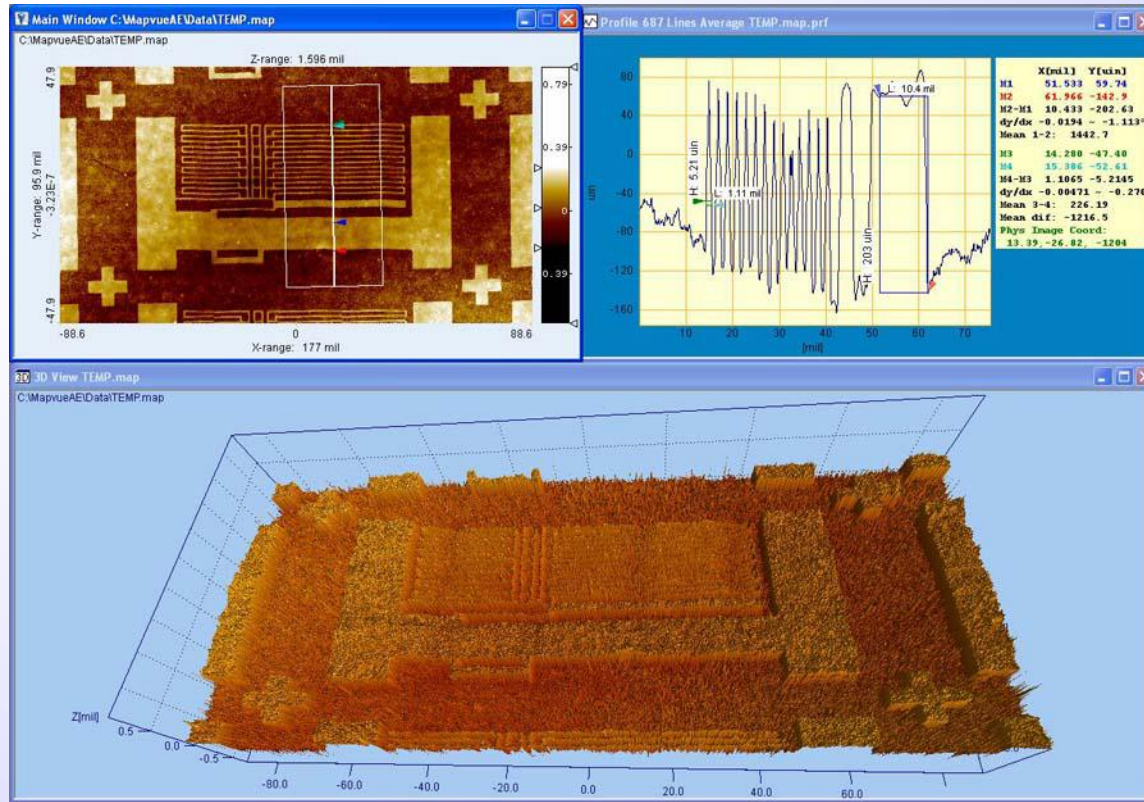
1 Giga Ohm Divider TCR



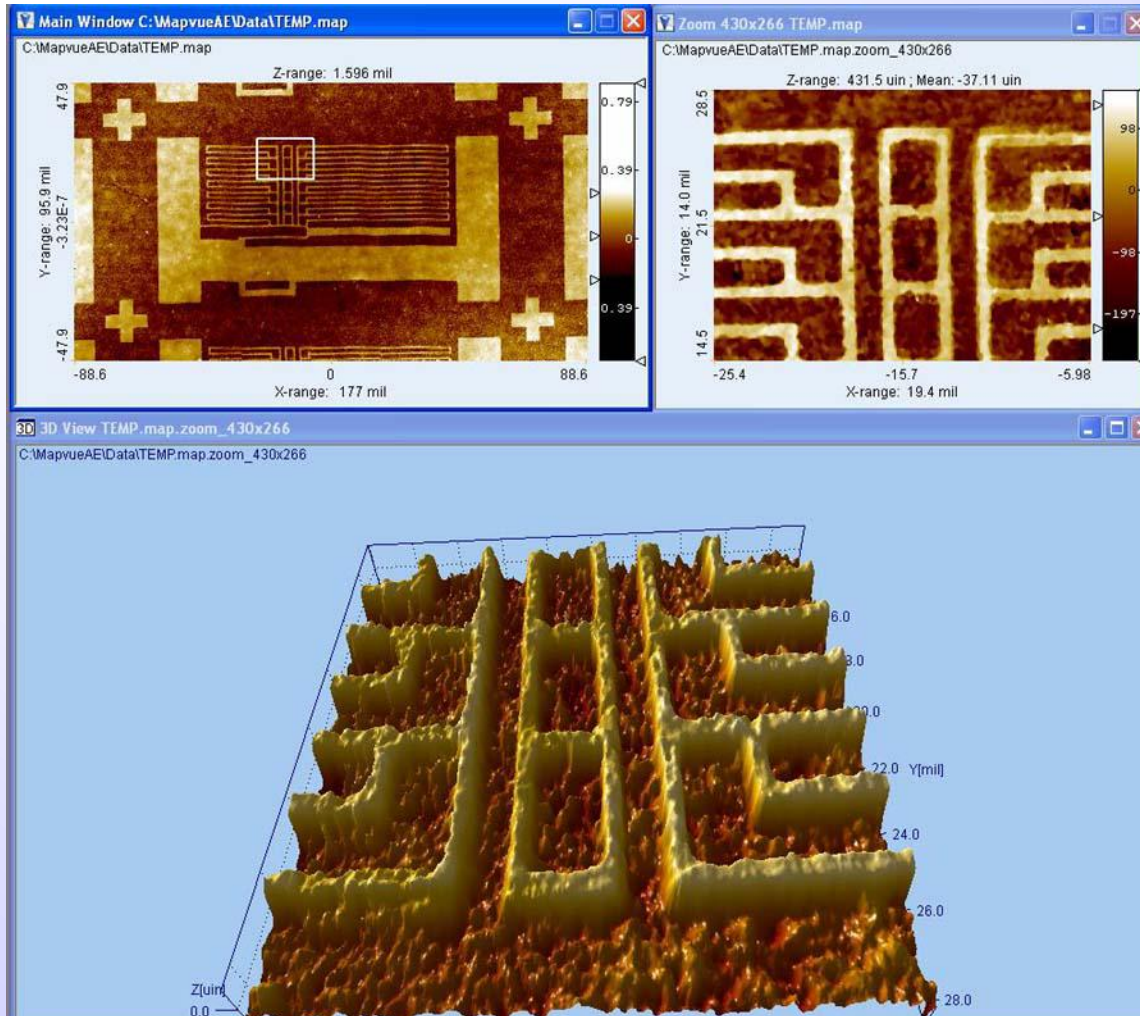
Other Examples 0202



Other Examples ladders and shunts



Other Examples close-up



Conclusion

Very large aspect ratio serpentine resistors improve the electrical performance of high ohmic value thick film resistors by allowing the use of the most optimum materials. Photo patterning is a process which enables designers to realize the improvements in an eminently manufacturable way.

Benefits from photo patterned lines

- Uniform thickness and line width
- Reduced VCR
- Lower TCR
- Better tracking of TCR and VCR, in networks
- Lower Noise
- Better power handling
- Reduced variability increases yields
- Process feedback enables etching to value, accommodating for batch variability in screening
- In process control enables 5% tolerance without trimming