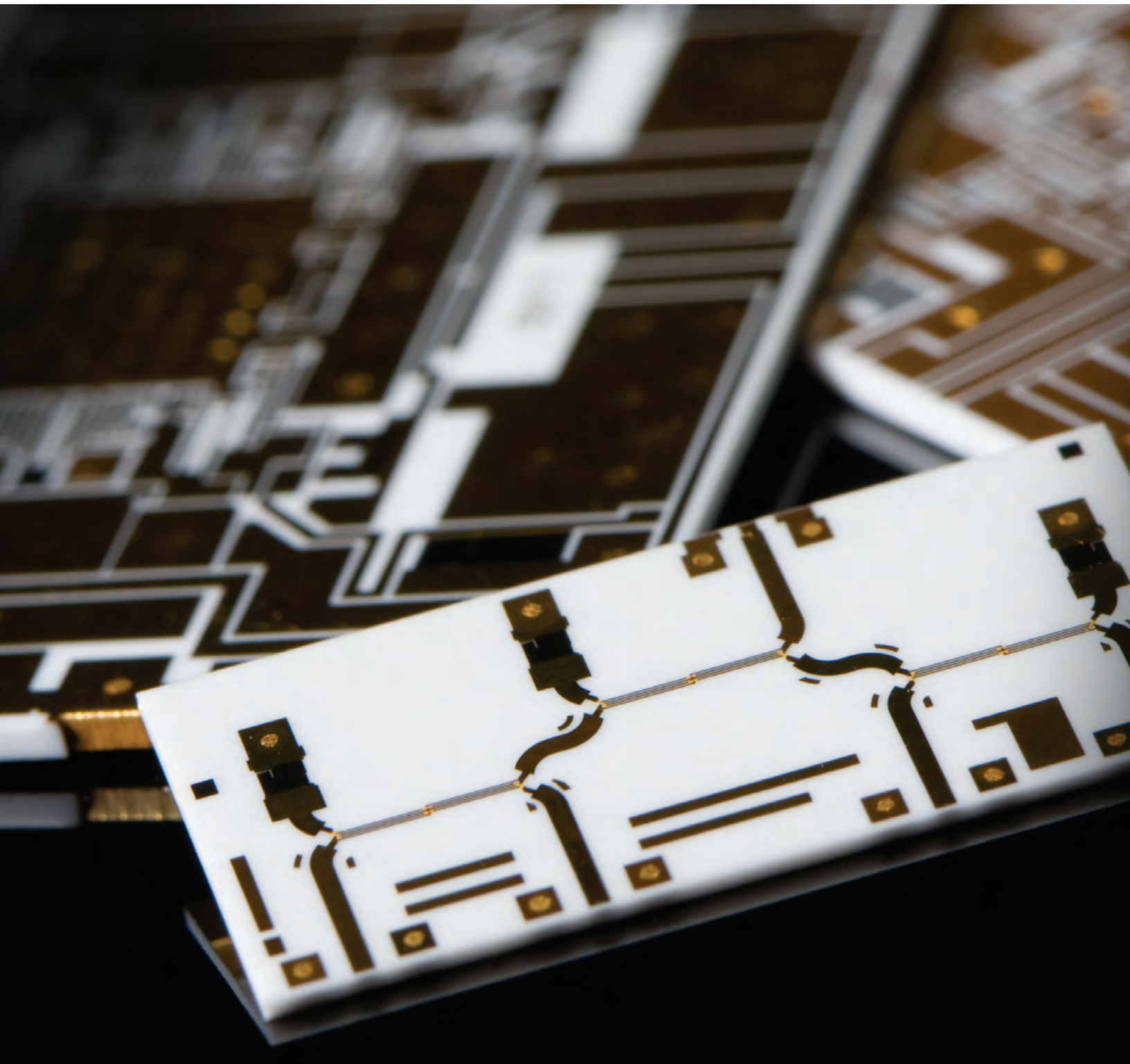
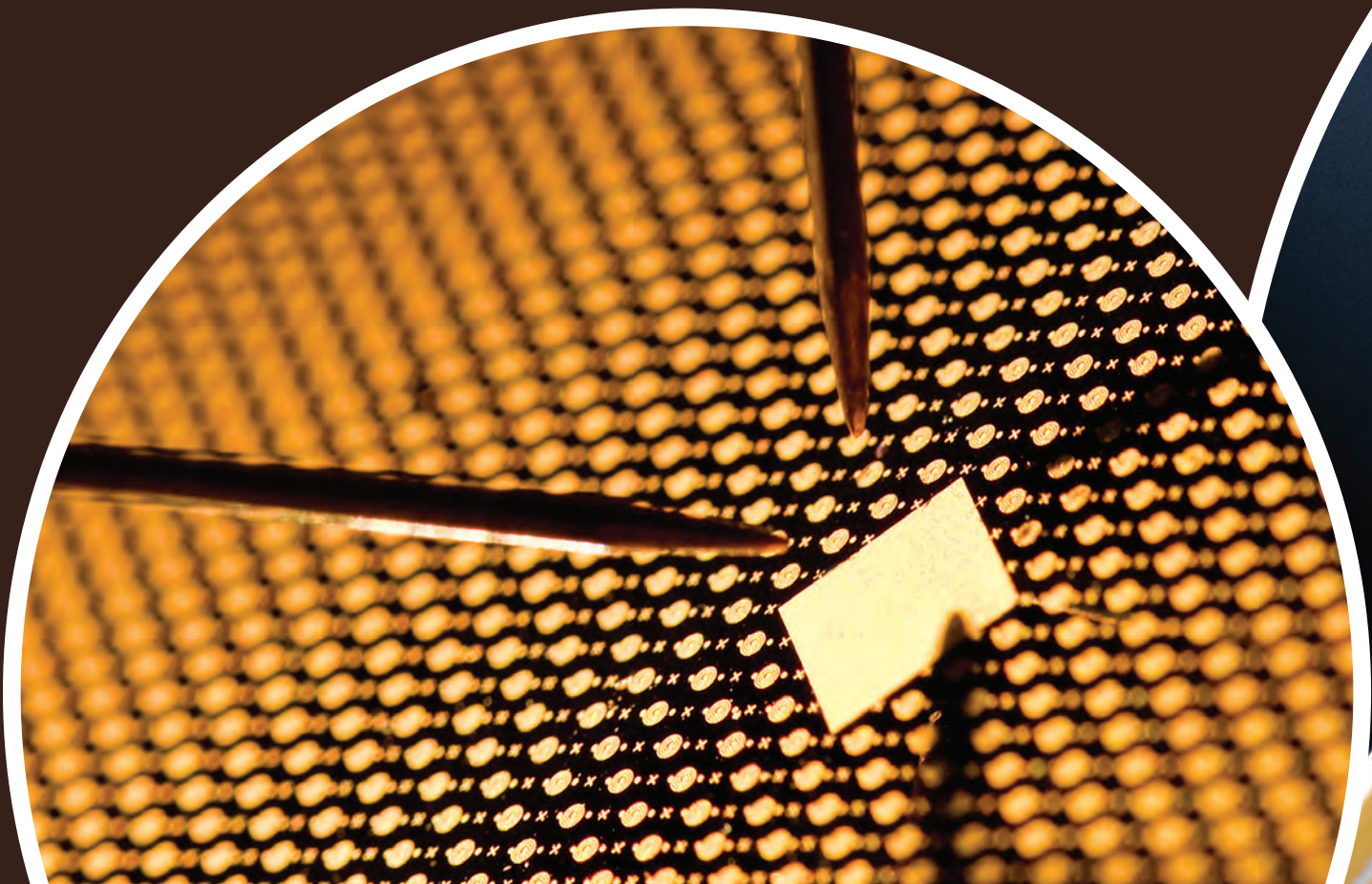


Advanced Thin Film Technologies

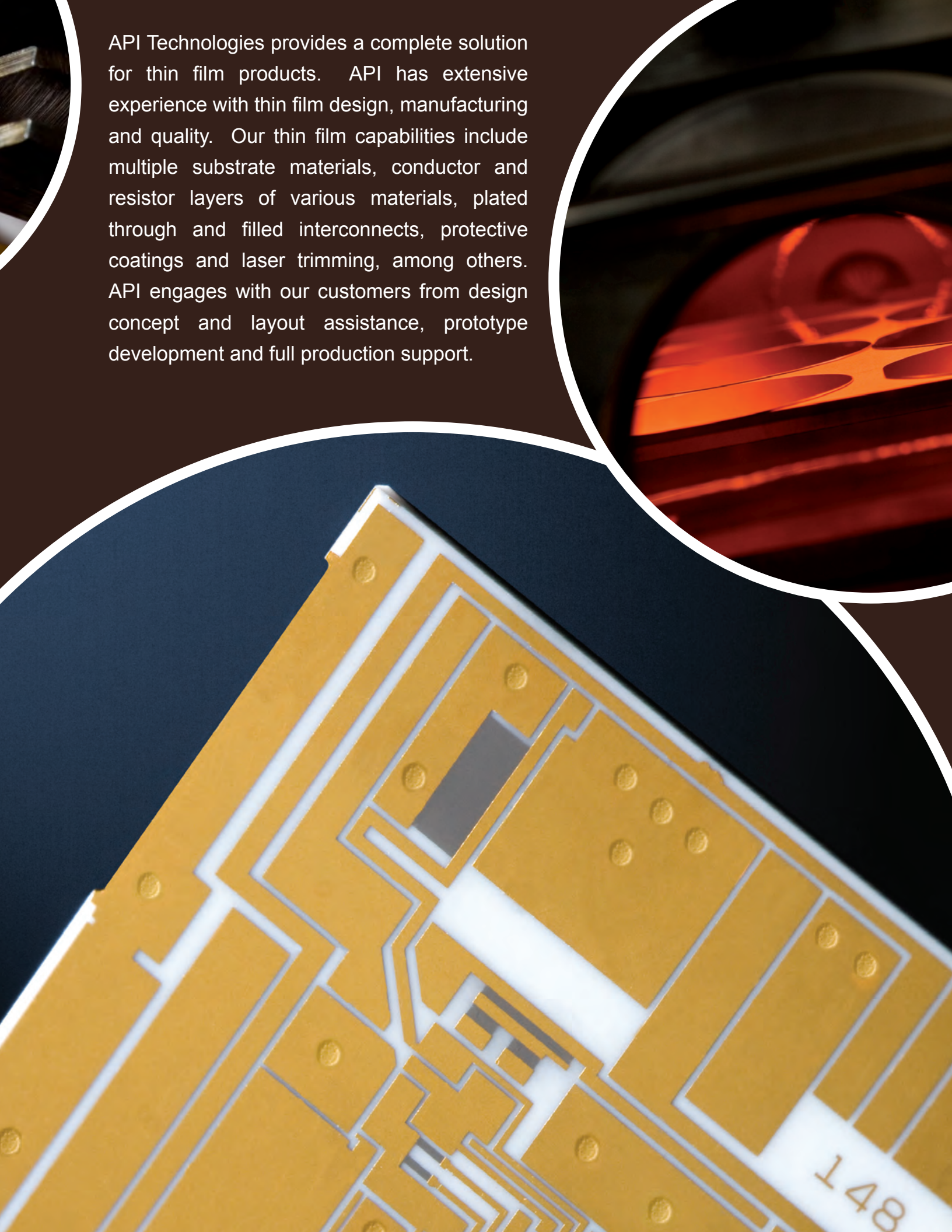


API Technologies' reputation among space, military and commercial markets is second to none. API's Marlborough facility have been building upon this reputation in the industry with exceptional service and technical expertise.

API Technologies has over 4 decades of thin film experience. This experience will enable API to provide thin film products that meet or exceed our customer's expectations for performance, price and delivery. API prides itself in delivering the highest quality products for a complete solution for total customer satisfaction.



API Technologies provides a complete solution for thin film products. API has extensive experience with thin film design, manufacturing and quality. Our thin film capabilities include multiple substrate materials, conductor and resistor layers of various materials, plated through and filled interconnects, protective coatings and laser trimming, among others. API engages with our customers from design concept and layout assistance, prototype development and full production support.



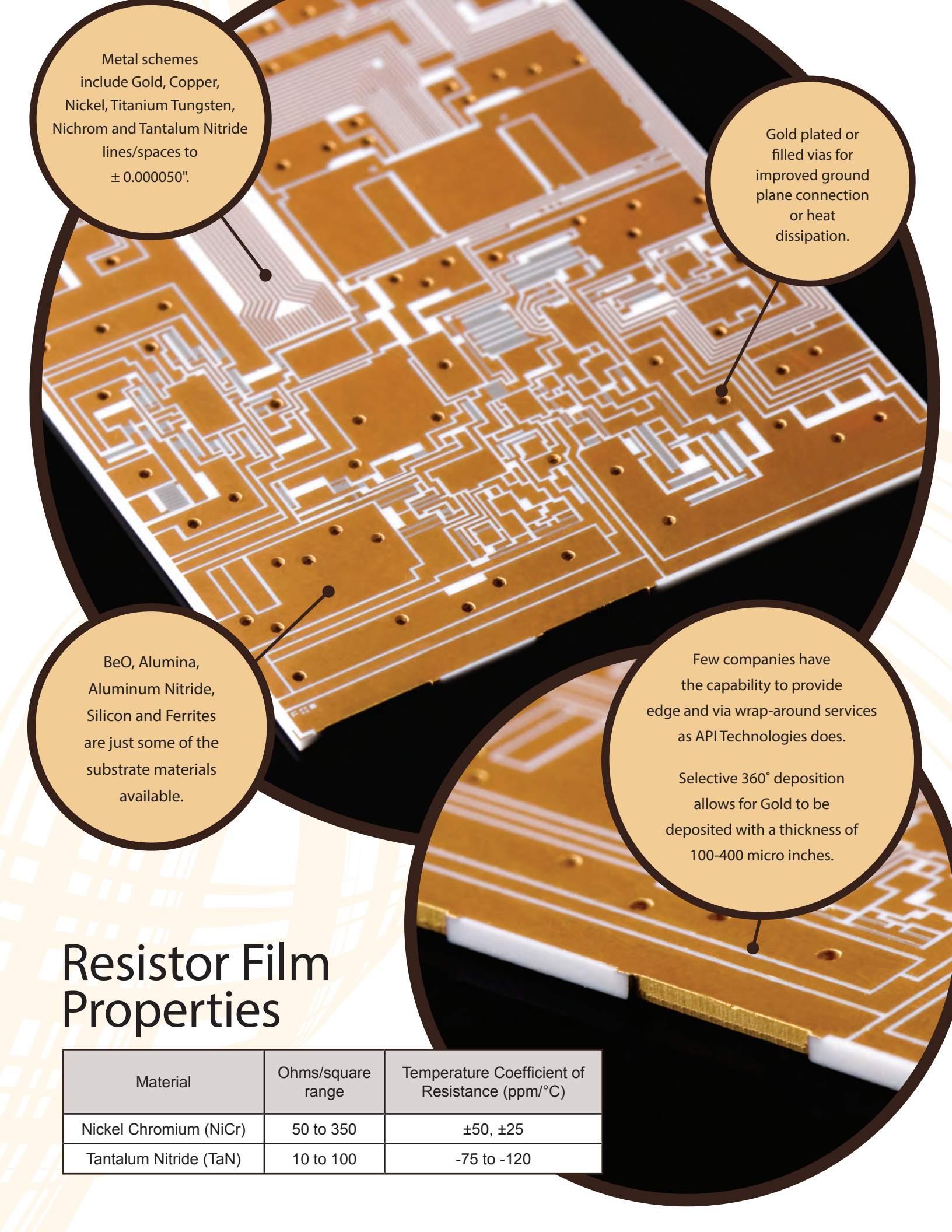
For more information please call us at

888-553-7531

Substrates

API commonly uses several different materials for our thin film products, including alumina, beryllium oxide, aluminum nitride, fused silica quartz, titanates, ferrites and garnets. The materials are chosen for suitability for the application. Alumina is the most common substrate, but applications with high power dissipation tend to use BeO and AlN substrates for their thermal conductivity and high frequency applications would tend to use fused silica quartz for its low dielectric constant. The table below provides some typical properties of common thin film substrates.

Properties	Units	99.6% Alumina	Beryllium Oxide	Aluminum Nitride	Fused Silica Quartz
Molecular Structure		Al ₂ O ₃	BeO	AlN	SiO ₂
Density	g/cm ³	3.87	2.85	3.28	2.2
Coefficient of Thermal Expansion (CTE)	10 ⁻⁶	7.0-3	9.0	4.6	0.55
Thermal Conductivity	Watts/m-K	26.9	270	170	1.3
Dielectric Constant		9.9	6.5	8.6	3.83
Dissipation Factor @ 1 MHz		0.0001	0.0004	0.001	0.000015



Metal schemes include Gold, Copper, Nickel, Titanium Tungsten, Nichrom and Tantalum Nitride lines/spaces to $\pm 0.000050"$.

Gold plated or filled vias for improved ground plane connection or heat dissipation.

BeO, Alumina, Aluminum Nitride, Silicon and Ferrites are just some of the substrate materials available.

Few companies have the capability to provide edge and via wrap-around services as API Technologies does.

Selective 360° deposition allows for Gold to be deposited with a thickness of 100-400 micro inches.

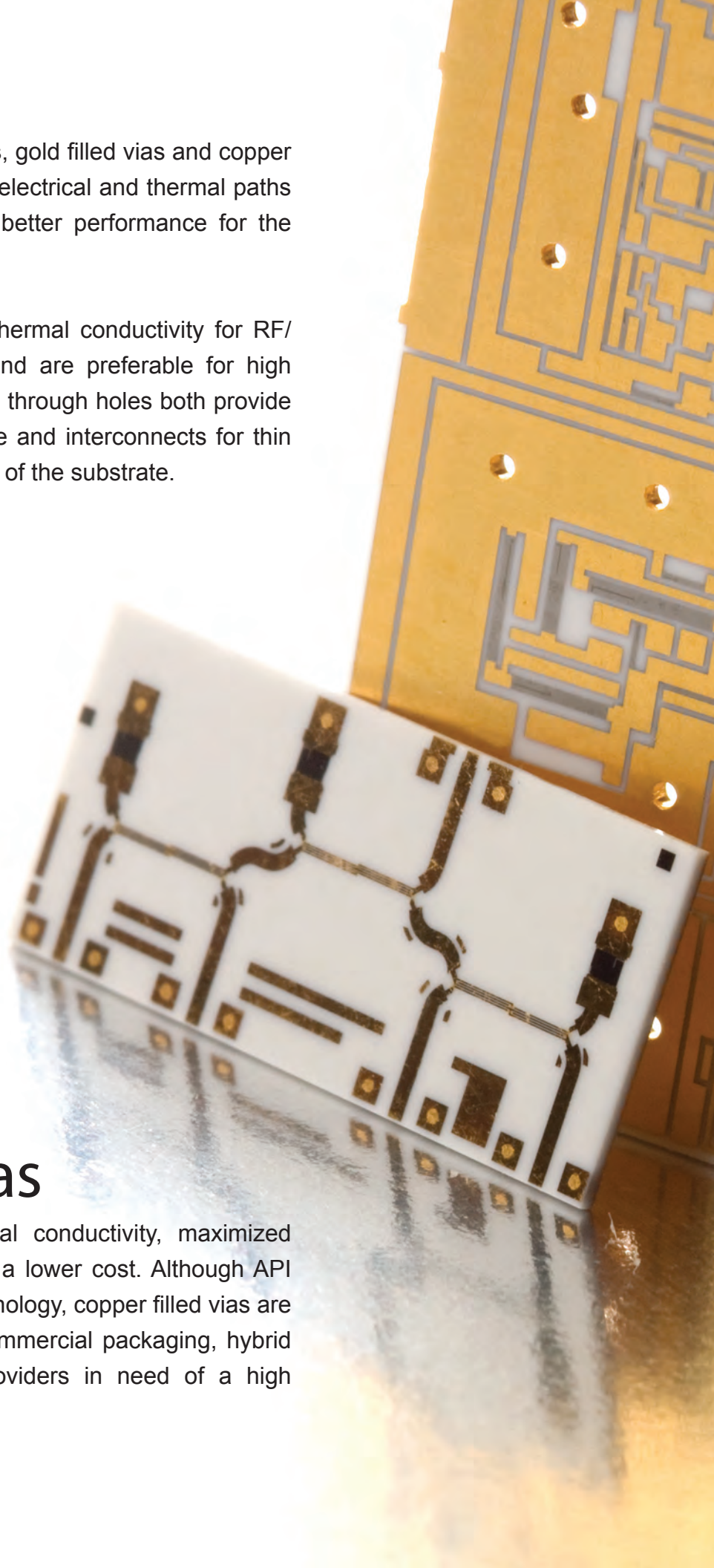
Resistor Film Properties

Material	Ohms/square range	Temperature Coefficient of Resistance (ppm/°C)
Nickel Chromium (NiCr)	50 to 350	$\pm 50, \pm 25$
Tantalum Nitride (TaN)	10 to 100	-75 to -120

| Vias |

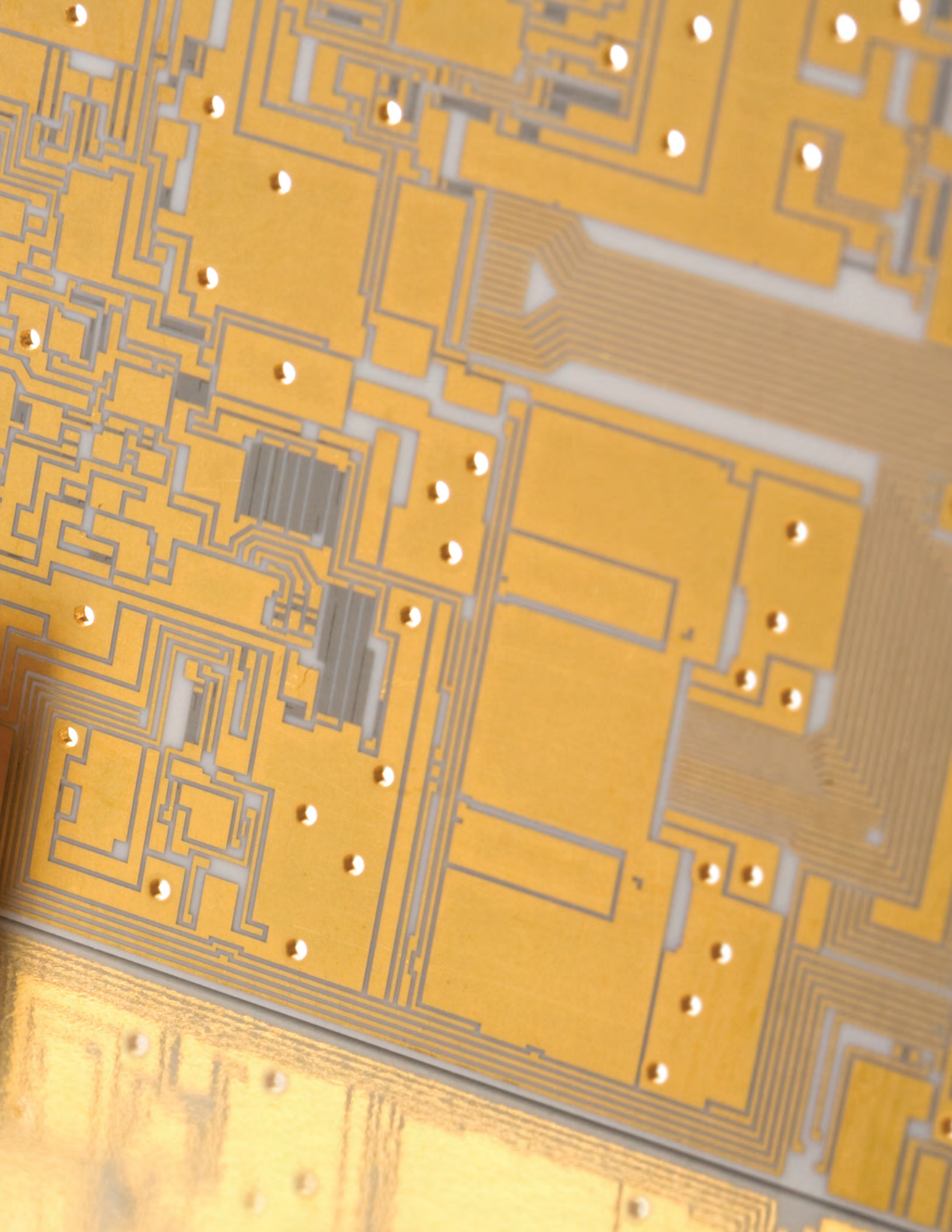
API Technologies offer plated through vias, gold filled vias and copper filled vias. These vias allow for excellent electrical and thermal paths to the ground plane, which will provide better performance for the intended application.

Filled vias provide better electrical and thermal conductivity for RF/Microwave than plated through holes, and are preferable for high power applications. Filled vias and plated through holes both provide electrical connections to the ground plane and interconnects for thin film substrates with patterns on both sides of the substrate.



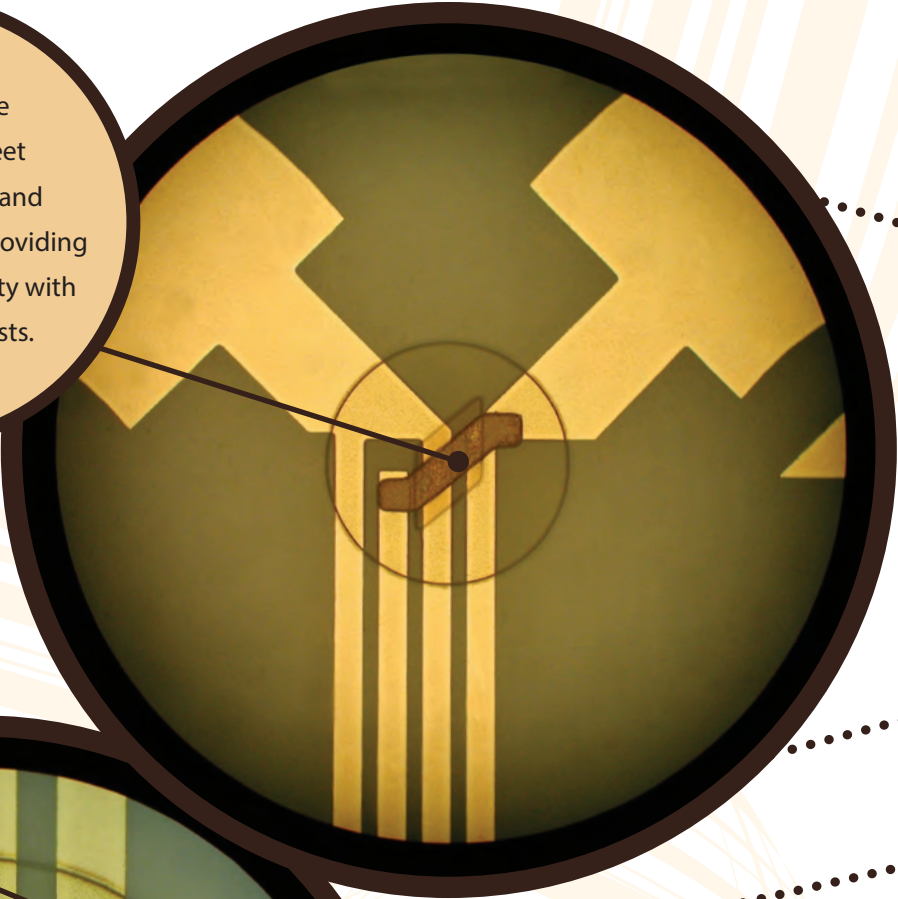
Copper Filled Vias

Copper filled vias feature high electrical conductivity, maximized thermal conductivity, and reliability all at a lower cost. Although API supports nearly all thin and thick film technology, copper filled vias are the preferred technology available for commercial packaging, hybrid manufacturers, and microelectronics providers in need of a high reliability and high conductivity substrate.

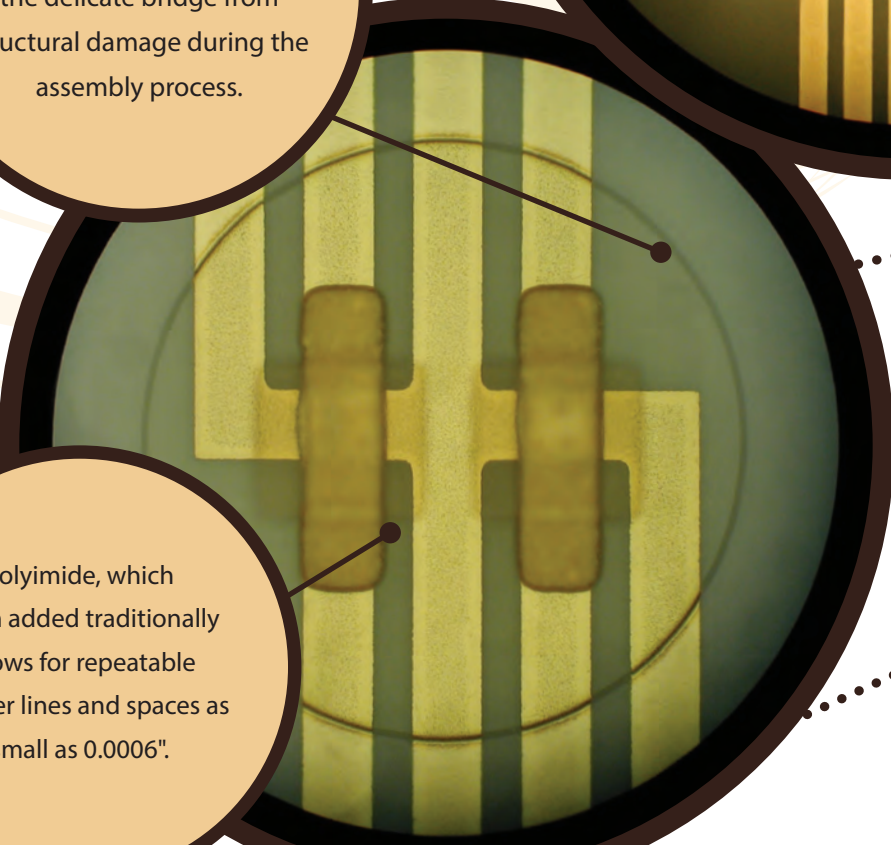


| Polyimide Bridges & Dams |

Another example of adding value through innovation is utilizing Polyimide for bridges and dams. The advantage of poly bridges over traditional air bridges in microwave couples is the non-conductive polyimide adds a level of support preventing the bridge from collapsing onto the circuit below. API has taken that process one step further by adding a second layer of polyimide on top of the bridge, complementing the foundation of structural integrity added to the bridge process by the base Polyimide layer.



Polyimide can be customized to meet a variety of shapes and dimensions, thereby providing versatility and flexibility with your design requests.

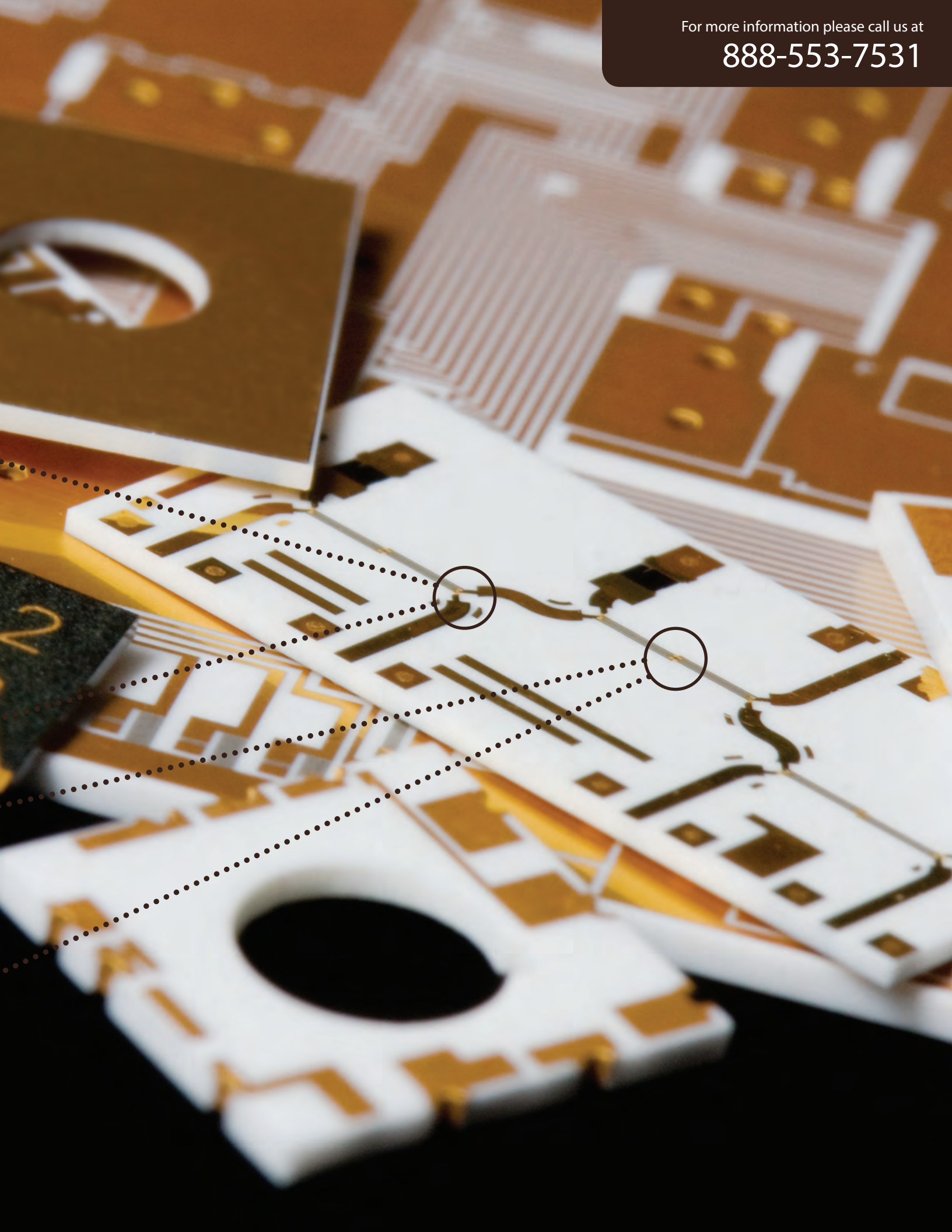


Adding a second layer of Polyimide helps protect the delicate bridge from structural damage during the assembly process.

Polyimide, which when added traditionally allows for repeatable coupler lines and spaces as small as 0.0006".

For more information please call us at

888-553-7531

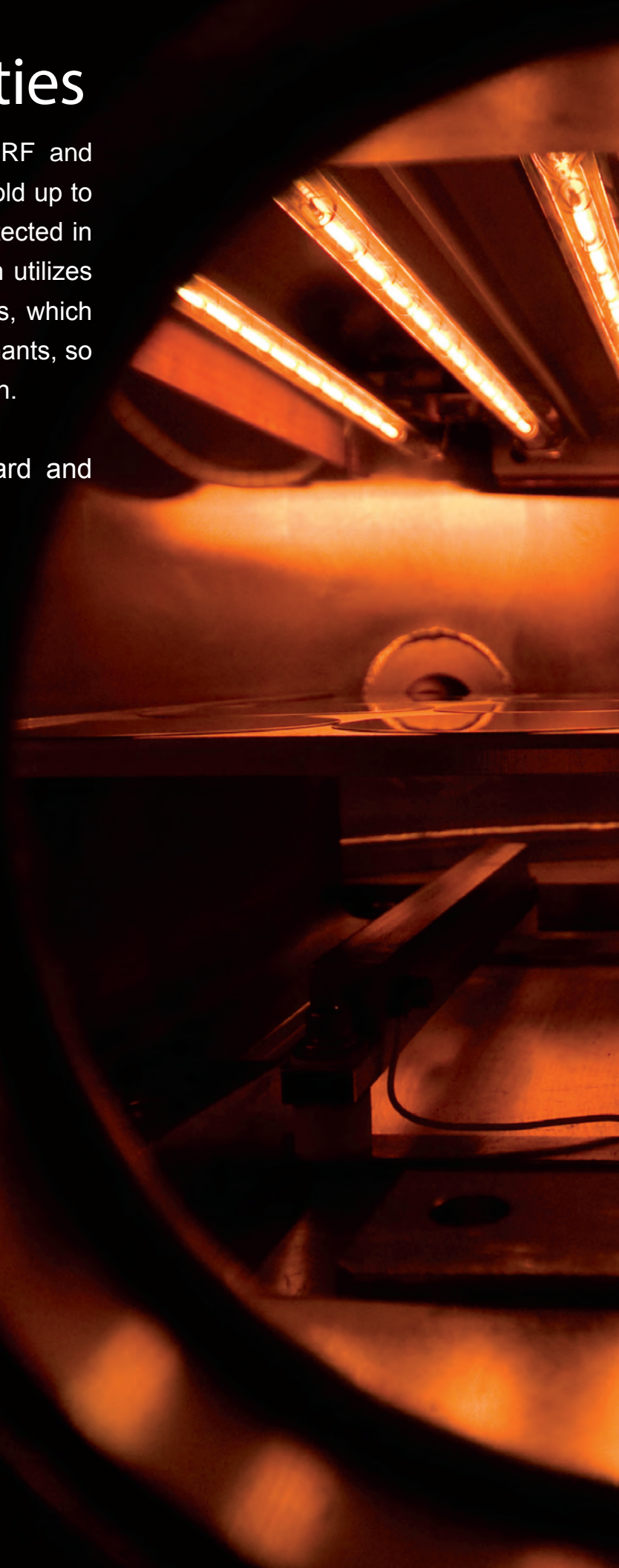


Sputtering Capabilities

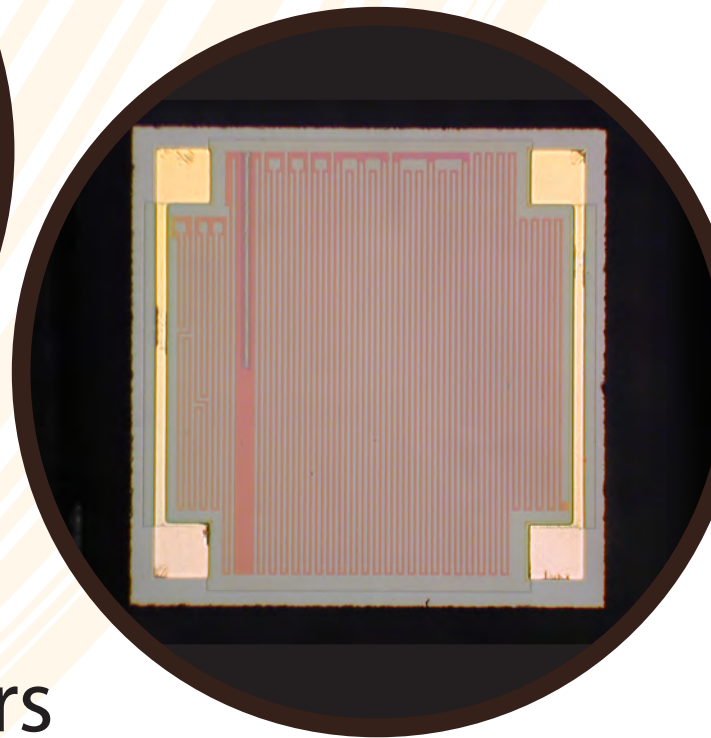
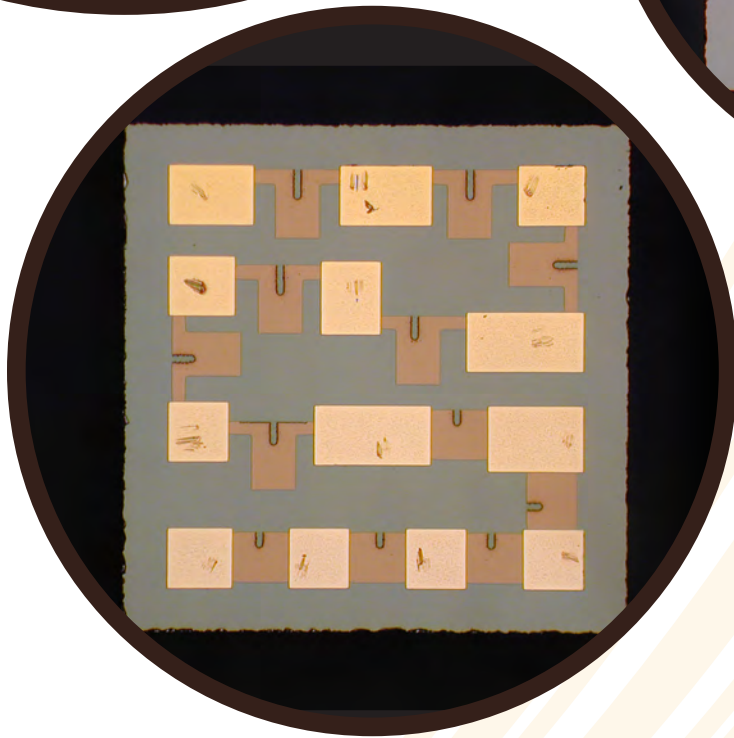
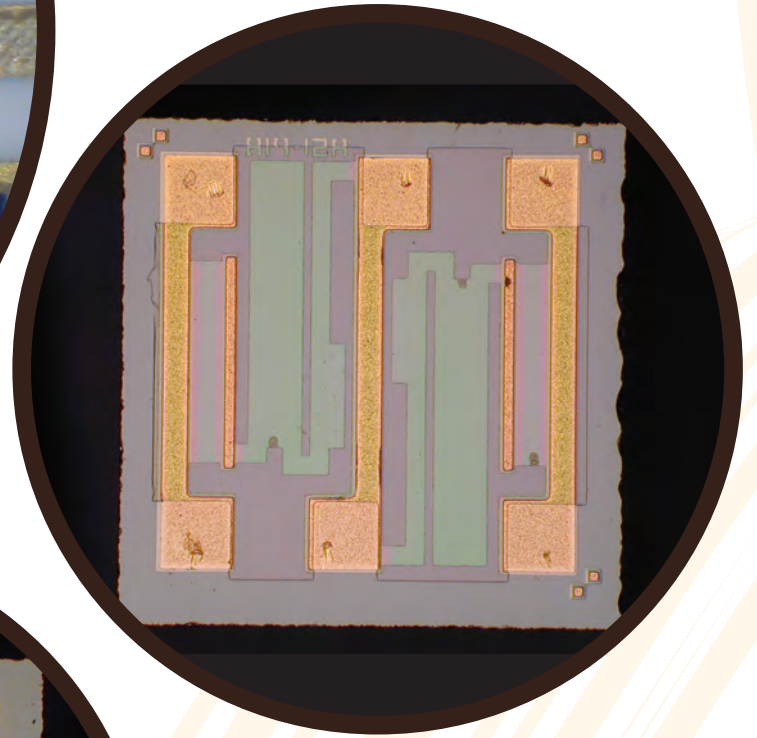
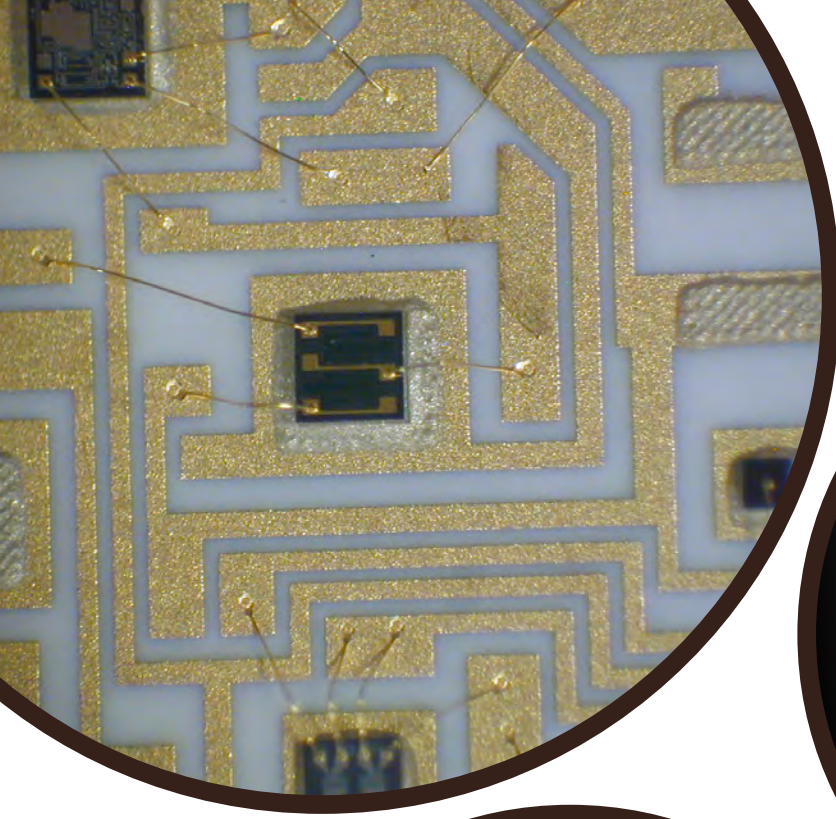
API Technologies has invested into several RF and DC sputtering systems. These systems can hold up to four metal targets, so the metal layers are protected in vacuum during processing. API's metallization utilizes load locks to maintain ultra-high vacuum levels, which leads to better film adhesion and less contaminants, so that the end-product is in line with the simulation.

We are specialists in a number of standard and exotic metals including:

- **Titanium Tungsten**
- **Nickel**
- **Platinum**
- **Chromium**
- **Palladium**
- **Gold**
- **Copper**
- **Aluminum**
- **Silver**







Thin Film Chip Resistors

API offers a wide variety of thin film chip resistors as standard products. There are multiple options available that provide options for substrate material, resistor material, temperature coefficient of resistance, resistor value and tolerance and size.

Core Competencies

- Silicon or alumina substrate
- Resistor tolerance 0.1%
- Back side contact options
- Pre-soldered options
- Tantalum Nitride or Nickel Chrome resistor materials
- Passivation as required

Processing Steps

- 100% sputter thin film
- Conductor and resistor photolithography and etch
- Stabilization
- YAG laser trim
- Passivation as required
- 100% Visual inspection

Chip Resistor Sizes

- Single Tap .020 x .020 Series
- Single Tap .020 x .040 Series
- Single Tap .030 x .030 Series
- Center Tap .030 x .030 Series
- Multi Tap .030 x .030 Series
- Single Tap .040 x .040 Series
- Single Tap .050 x .050 Series
- Single Tap .050 x .100 Series

Nichrome Specs (Oxidized Silicon / Electrical Data)

TCR.....	0 ± 50 ppm/°C max.
TCR Tracking.....	1 ppm/°C max.
Power Rating @ 70°C	
0.040" x 0.040".....	350 mW max.
0.030" x 0.030".....	250 mW max.
0.020" x 0.020".....	125 mW max.
Operating Voltage.....	200 V max.
Noise.....	-25 dB max.
Short Time Overload (2.5 x rated power @ 25°C for 5 seconds).....	± 0.02% max. ΔR/R
High Temperature Exposure.....	± 0.15% max. ΔR/R (150°C, 1000 hrs. in air)
Thermal Shock MIL-STD-202 Method 107	
Test Condition C.....	± 0.02% max. ΔR/R
Low Temperature Operation MIL-R-55342 Paragraph 4.7.4.....	± 0.02% max. ΔR/R
Resistance Ratio Accuracy	
.....	± 0.025% max. or ± 0.1 Ω (whichever is greater)
Absolute Resistance Tolerance	
.....	± 0.1% max. or ± 0.1 Ω (whichever is greater)

Tantalum Specs (Oxidized Silicon / Electrical Data)

TCR.....	-100 ± 50 ppm/°C max.
TCR Tracking.....	1 ppm/°C max.
Power Rating @ 70°C	
0.040" x 0.040".....	350 mW max.
0.030" x 0.030".....	250 mW max.
0.020" x 0.020".....	125 mW max.
Operating Voltage.....	200 V max.
Noise.....	-25 dB max.
Short Time Overload (2.5 x rated power @ 25°C for 5 seconds).....	± 0.02% max. ΔR/R
High Temperature Exposure.....	± 0.15% max. ΔR/R (150°C, 1000 hrs. in air)
Thermal Shock MIL-STD-202 Method 107	
Test Condition C.....	± 0.02% max. ΔR/R
Low Temperature Operation MIL-R-55342 Paragraph 4.7.4.....	± 0.02% max. ΔR/R
Resistance Ratio Accuracy	
.....	± 0.050% max. or ± 0.1 Ω (whichever is greater)
Absolute Resistance Tolerance	
.....	± 0.1% max. or ± 0.1 Ω (whichever is greater)

| Design Guide | Thin Film Metallized Substrates

This useful layout guide, with its accompanying metals and their functions outline, should help serve as a resource for both the CAD specialists, as well as the engineer involved in the design of the substrate or PC board. Helpful resistor values along with material types and their range of functions is included and is another example of why API Technologies leads the industry in both innovation AND customer service.

Sample Resistor Layout Guide

Parameter	Value Inches (µm)	Comment
Resistor Style Min Resistor Dim.	Type-1 0.002 x 0.002 (50 x 50)	Resistor inboard of conductor
Min . Probe Pad Dim.	0.003 x 0.003 (75 x 75)	Perpendicular to current flow
Conductor/Resistor Overlap	0.0005 (12.5) per side min. 0.002 (50) per end	Parallel to current flow

Metals and their Functions

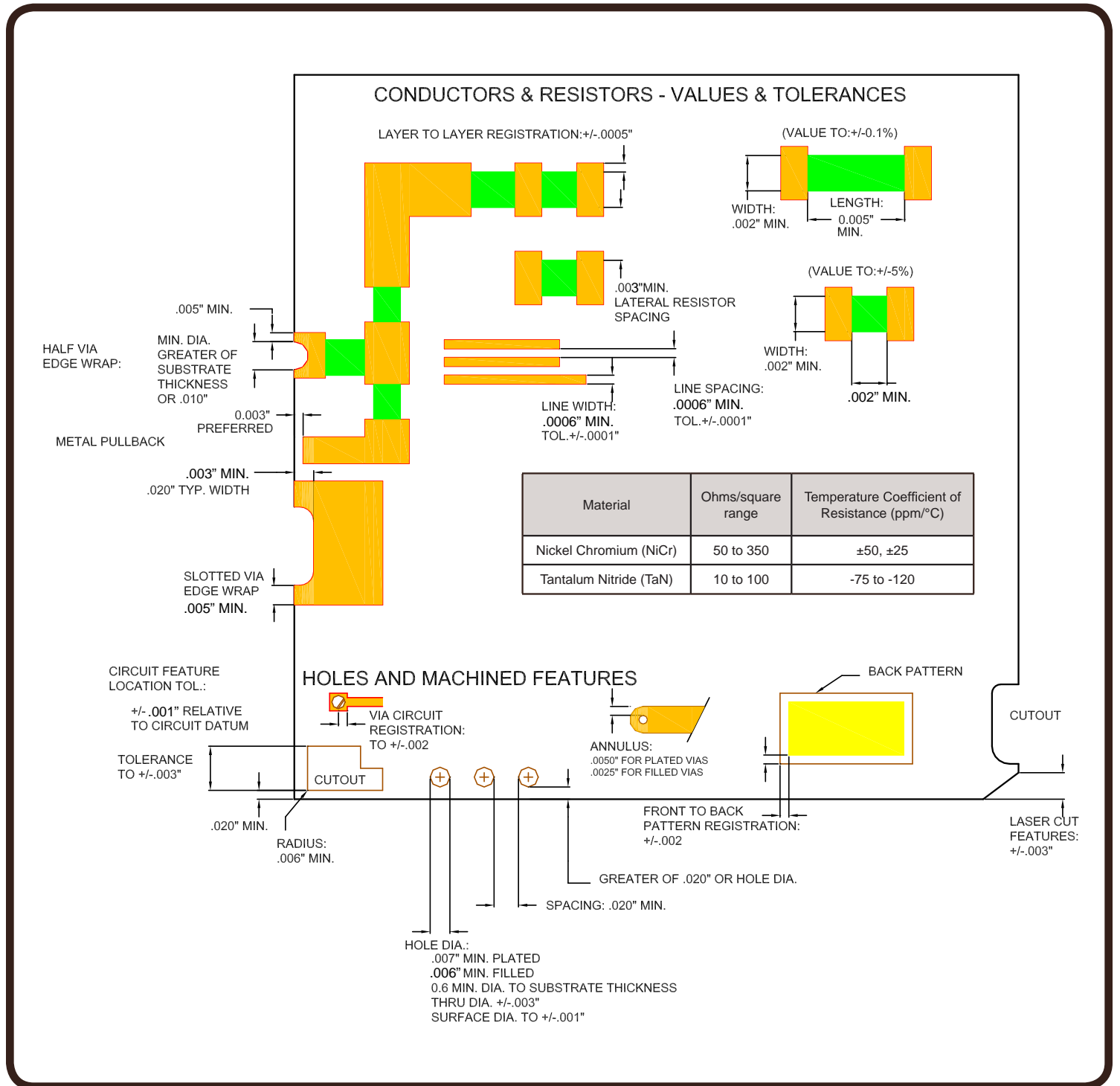
Material Function	Material Type	Range of Functions	Comments
Resistors	Tantalum-Nitride (TaN) Nickel-Chromium (NiCr) Chromium-Silicon (CrSi)	10 – 150 Ω/square (Min) 20 – 350 Ω/square (Min) 500 – 1500 Ω/square	Best for non-hermetic environment Low TCR Small package hi-value resistors
Adhesion	Titanium – Tungsten (TiW) Chromium (Cr)	250 – 750 Angstroms 250 – 750 Angstroms	Ideal for high temperatures Low temperature limitation
Barriers	Nickel (Ni) – Sputtered Nickel (Ni) - Plated	750 – 20000 Angstroms 40 – 100µ in. (1 - 2.5 µm)	Standard barrier High conductivity barrier
Conductors	Copper (Cu) Gold (Au)	30 – 500µ in. 10 – 200µ in. (0.25 - 5 µm)	High power/solderable Tight tolerance Fine line features available

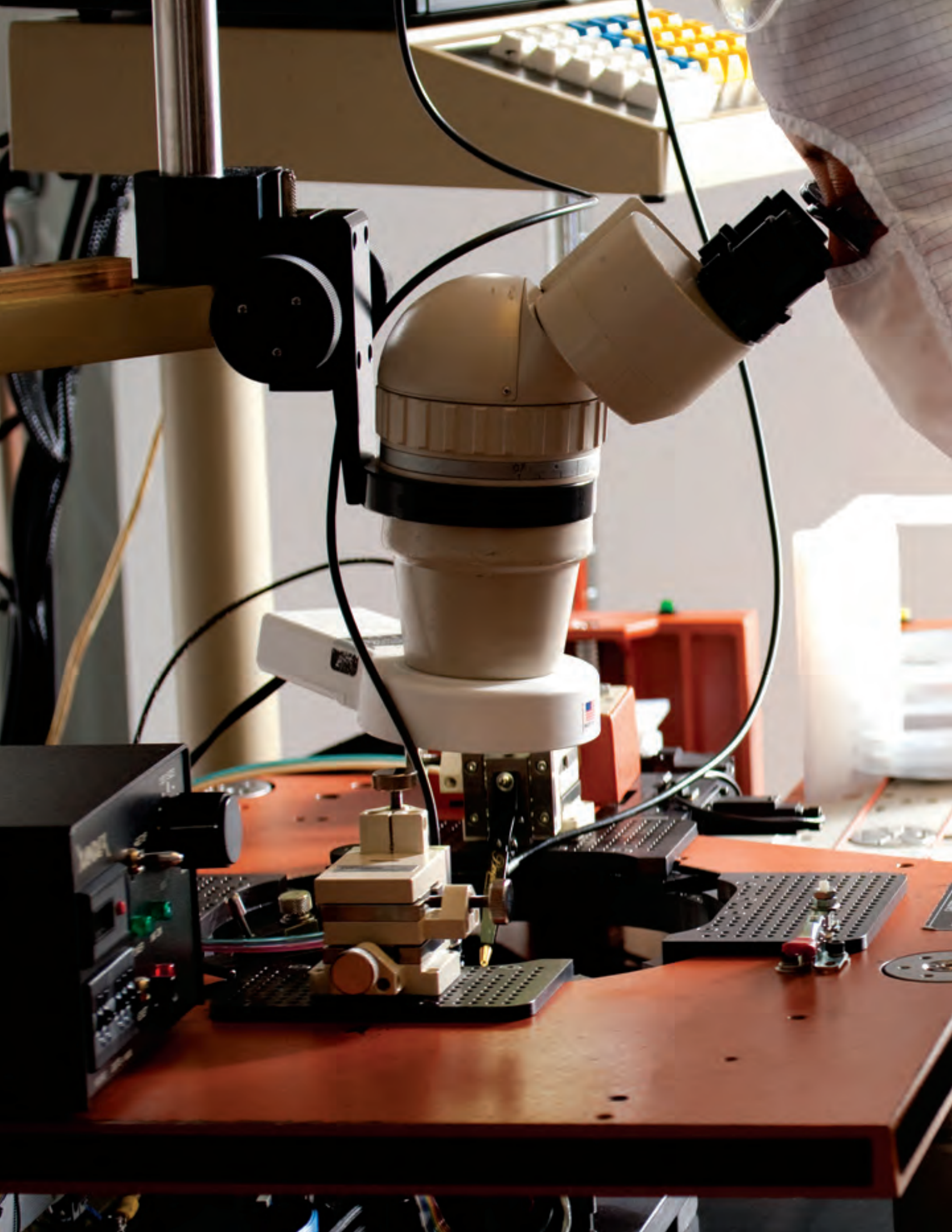
For more information please call us at

888-553-7531

Values and Tolerances Schematic

API Technologies knows that critical attention to artwork dimensions and tolerances is of paramount importance during a design packet transfer. To assist with this critical step in the design process, we provides an illustration as seen below, which includes suggested values and tolerances that should be followed in order to facilitate a complete and comprehensive design packet.





Quality Control

API Technologies' Thin Film product line is certified to MIL-PRF-38534 Class H and Class K by the Defense Logistics Agency Land and Maritime. This certification provides assurance that the Thin Film products manufactured at API are suitable for applications requiring the highest reliability, including military and space applications. API Technologies is in a class by itself with its own Thin Film fabrication line that directly supports and provides Thin Film chip resistors, substrates and interconnect products for its MIL-PRF-38534, Class H and K compliant hybrid microcircuits. Our facility is also certified to AS9100, which is the quality management system for the aerospace industry.

API's Thin Film products all have the highest quality screenings which will provide assurances of performance and reliability for any application.

For more information please call us at

888-553-7531

API Technologies

Design & Development Process



API Technologies strict adherence to ISO controlled processes guarantees that from conception to design development, and production to final inspection, an API team member is carefully following the project at every stage.

Quality Assurance

- AS9100 Certified
- MIL-PRF-38534 Certified to Class H and K by Defense Logistics Agency (DLA) Land and Maritime

Manufacturing

API's Marlborough Operation is certified as a MIL-PRF-38534 Class K facility. This qualification assures that customers will receive the highest degree of process control and refinement at every phase in the manufacturing process.





1

Engineering

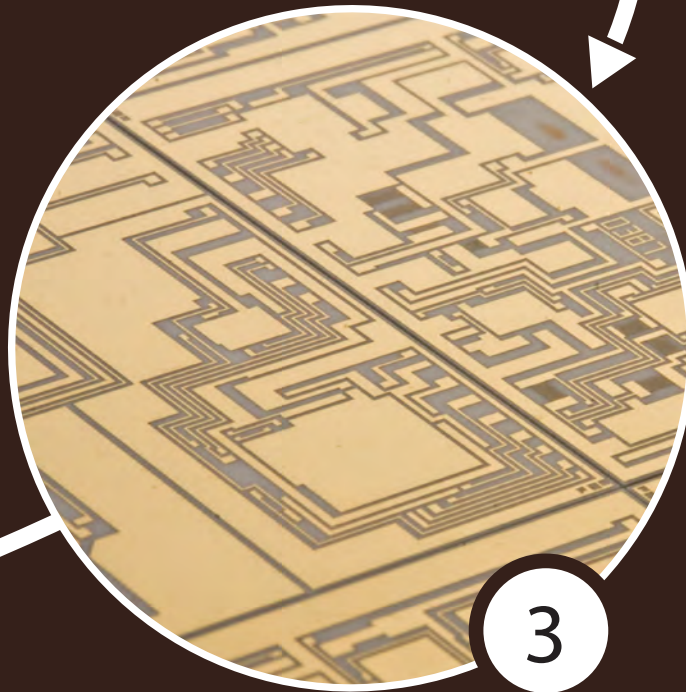
API Technologies' techniques in valuable metals deposition, wrap-around gold and double polyimide applications, clearly show why we are leaders in the development of new thin film methods and processes.



2

Layout & Design

Using the latest design tools including *AutoCAD*, *Ansoft Designer*, *Agilent ADS* and *Genesys*, *Cadence Allegro*, *SolidWorks*, and *Sonnet Professional 3-D EM Simulator*, API's engineers can seamlessly transfer most incoming CAD drawings and files saving both valuable time and production costs.



3

Approval Process

Prototyping and first article inspections are of paramount importance to qualifying a fabrication partner. API Technologies assures your total satisfaction by conducting a thorough technical review of every aspect of your project and reviewing any questions or suggestions for improvement one-on-one.



4

For more information please call us at

888-553-7531

| Design Resources |













<http://micro.apitech.com>

API Technologies' website features complete information on all standard products with thousands of product datasheets. API's customers enjoy free engineering tools, tours, application notes, white papers, and the ability to create a custom designed product per individual specifications.

API Technologies' Online Engineering Design Tools

http://micro.apitech.com/engineering_tools

ENGINEERING TOOLS

-  **Cascade Design Tool**
The CASCADE program gives engineers the capability to quickly select RF/Microwave components and predict system performance.
-  **Package Outline Drawings**
Review the Drawings of our different packaging options for our Frequency Components.
-  **VSWR Reduction**
This calculator is used to improve your system's phase and amplitude variation performance.
-  **PI and Tee Attenuator Networks**
These calculators enable quick calculation of PI and Tee attenuator networks matched to 50 ohms. Enter your attenuation value and determine the appropriate resistance values with one click.
-  **Conversions**
Calculators for common conversions for noise, power, temperature, and reflection coefficients help the RF/microwave engineer review and convert specifications.
-  **Glossary of RF/Microwave Terms**
API Technologies presents definitions of useful RF and microwave terms.
-  **Application Notes**
These documents review how our solutions are implemented into applications or designs.
-  **White Papers**
Technical guides to demonstrate application issues and how to solve them. Use these to educate yourself from the technical perspective.
-  **Wireline/Wirepac Calculator**
Use this calculator to choose the right quadrature coupler and hybrid products!
-  **Radar Frequency Bands**
API Technologies' engineers design amplifiers using the list of radar frequency bands found here!



API Technologies Corp. is a trusted provider of RF/microwave, microelectronics, and security solutions for critical and high-reliability applications. The company designs, develops and manufactures electronic components, modules, systems and products for technically demanding defense, commercial/industrial and aerospace applications. API Technologies' customers include many leading Fortune 500 companies, as well as a majority of NATO governments. While API was founded in 1981, our heritage brands have served the demanding, hi-rel marketplace for more than 60 years. API Technologies trades on the NASDAQ under the symbol ATNY.

www.apitech.com +1.888.553.7531