

Remtec's Approach to Thick Film Matches Thin Film up to ka-Band Applications

Introduction

Remtec is a leading provider of custom ceramic thick film boards, including fabrication of thick film ceramic single-layer and multi-layer custom boards that fulfill various domestic manufacturing needs of the electronics industry. All Remtec products are designed, developed, and produced in the USA utilizing proven processes, procedures, and equipment to address today's thick film challenges and far exceed the capabilities of our competitors. Thick film boards are a key miniaturization techniques and economical way to realize electronic devices/modules; by employing plated copper on thick film (PCTF®) and direct bonded copper (DBC) thick film technologies in unique ways, Remtec's thick film solutions offer a valuable option for electronic devices/modules such as surface mount devices modules, hybrid integrated circuits, heating elements, integrated passive devices and high-power, RF and microwaves, optoelectronics, and sensor applications.

Merits of Thick Film Technology

Thick-film circuits/modules are widely implemented throughout the industry, such as space electronics, consumer electronics, aerospace and defense, and measurement system applications where high reliability is needed. Thick film technology is used in modules/substrates/boards, where interconnects and wiring is printed using additive manufacturing of screen printing the conductors; additionally, resistors, inductors, and capacitors are also screen printed; and thick film interconnects and pads are made compatible with surface-mount technology (SMT) and surface-mountable discrete parts (resistors, capacitors, ICs, etc.), so parts are assembled on a thick film substrate. In all, the prime deposition technique is screen printing (stenciling) inks on the ceramic boards.

The manufacturing of thick film boards is an additive process involving deposition of several (typically max 6–8) successive ceramic layers of conductive, resistive and dielectric layers onto Alumina (Al₂O₃), Aluminum Nitride (AlN) or Beryllium Oxide (BeO) an electrically insulating substrate using screen-printing and etching processes. Typical thick film thicknesses range from is 0.003 to 3 mil based on the power handling, bonding, soldering, and epoxying requirements. >>>

As an efficient and cost-effective manufacturing method, Remtec's proprietary PCTF approach is applicable to volume production of project specific custom boards that integrate active and passive components such as resistors, monolithic chips, thermistors, and integrated passive devices.

Thick film deposition and firing is a leading, tried and true, and well established printed film technology for hybrid integrated circuits. Remtec uses already prepared inks that are obtained from several companies for the optimum performance and the thick film screen printing. These inks for circuits, electrodes, terminals, resistors, dielectric layers etc. are prepared by mixing the metal or ceramic powders with solvents (ceramic thick film pastes) or polymer pastes to produce homogeneous pastes. With the advances in inks, today's thick film performance at Remtec is comparable to that of thin film technology up to 40 GHz (ka-Band). A comparison data is shown in the Figure 1 below. >>>

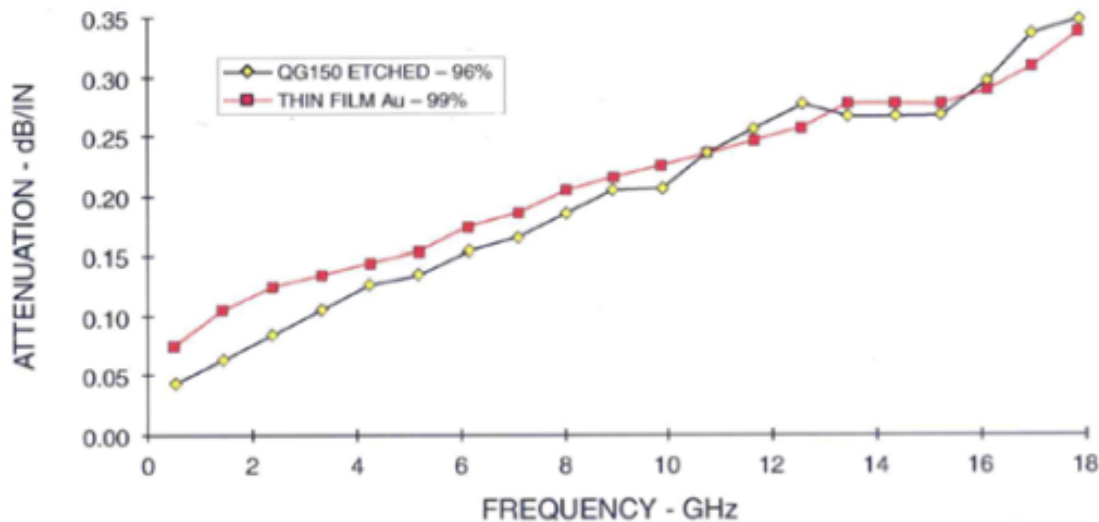


Figure 1: 50 Ohm Line Loss in dB/in Data from Celanese Remtec Thick Film Metallization/Deposition Technologies – Plated Copper Thick Film (PCTF) Direct Bonded Copper (DBC)

Thick film is a layer of copper deposited on the ceramic (Al_2O_3 , AlN) substrates known as PCTF (plated copper thick film) or bonded copper film known as DBC (direct bonded copper). The plated copper thickness to the substrates ranges from $10\mu\text{m}$ ($\approx 1/3\text{oz}$) to $100\mu\text{m}$ (3oz) in PCTF, while traditional PCB ranges from $100\mu\text{m}$ (3oz) to $280\mu\text{m}$ (9 oz) using DBC technology. Typical ceramic boards can have various final finishes such as gold, silver and copper as shown in Figure 2. An amplifier boards is shown in Figure 3 using PCTF metallization with printed resistors and capacitor structures. Table 1 lists the PCTF and DBC characteristics.



Figure 2: Thick Film Ceramic PCB Examples

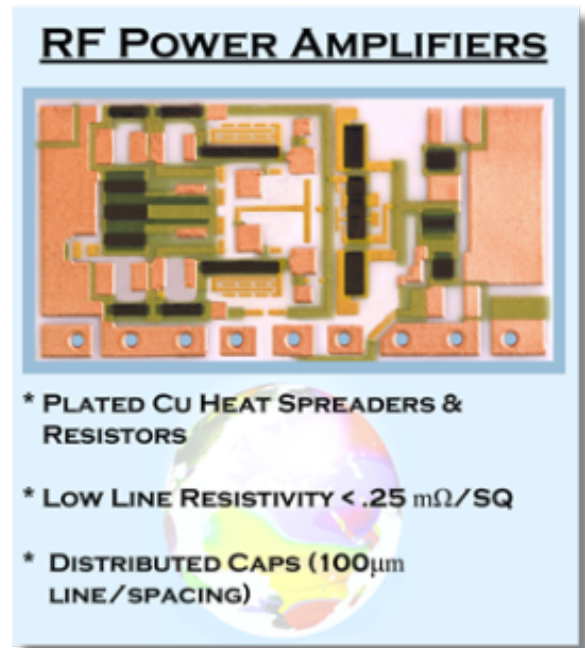


Figure 3: Example of a ceramic board with resistors and capacitors.

Property	PCTF	DBC
Compatible Substrates	Al ₂ O ₃ / AlN / BeO	Al ₂ O ₃ / AlN
Substrate Thickness (mils)	10/15/25/40/80/100	25/40/80
Copper Weight (oz)	10 - 140	140 - 350
Panel Sizes (in ²)	Standard:	Standard:
	Special:	Special:
Min Trace Width (mil)	6mil/4mil	8mil
Min Hole Diameter (mm)	0.08	0.08
Plated Thru Holes (mils)	6 to 15	6 to 15

Table 1: Ceramic PCB Manufacturing Capabilities

Multi-Layer Ceramics (Alumina, BeO and AlN)

Remtec multilayer ceramic substrate technology is ideal for RF and hybrid electronics applications. These ceramics provide high reliability, high thermal conductivity, and low dielectric loss and, as such, are used in applications such as inductors, capacitors, filters, resistors, and interconnections between layers to yield compact packages. Remtec has developed several multilayer custom ceramic boards on Alumina, BeO and AlN. Dielectric layers of 1 mil thickness are deposited and vias created on either side of the base substrate. These can range from 3 to 5 layers. Metallization is screen printed on the base substrate and fired before adding, dielectric layer is then deposited, fired and metallization is screen printed as desired, and repeat the process until the board with all the layers is finished.

Remtec's capabilities enable the creation of RF embedded structures such as power combiners, hybrids, filters and other structures. MMICs can also be strategically mounted to realize compact fully functional circuits such as power amplifiers, down converters, and other complex structures.

A typical structure for a microelectronic circuit is shown below. We can also vary the dielectric constant of the layers between 6 to 12, thus providing customers a wide range of design capabilities. Remtec also has capabilities to manufacture 3D structures, as well as miniaturized substrate integrated waveguide structures, including couplers and transitions from waveguide to microstrip line and strip line. We can also build transposer boards to go between two different boards to enable 2.5D and 3D integrations. >>>

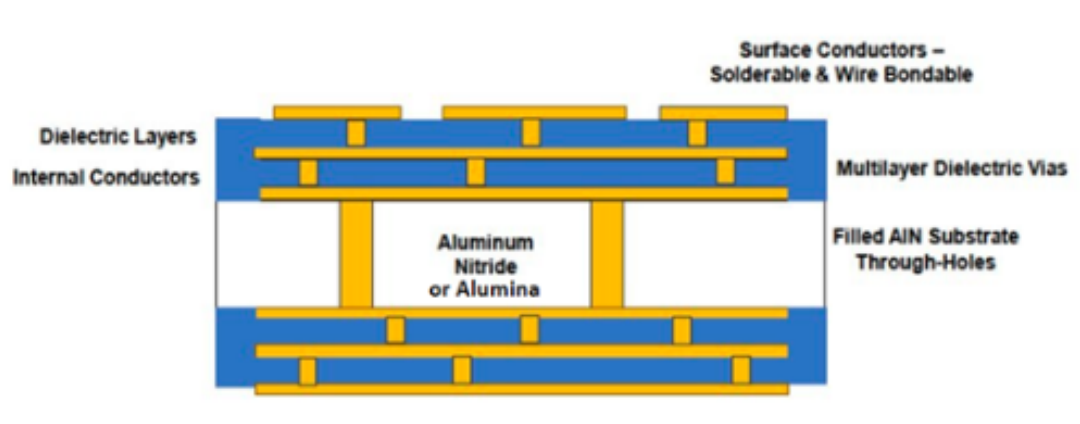


Figure 4: Example multilayer ceramic circuit design

Discussion

Remtec provides custom ceramic board level solutions to a broad market with its diverse technologies and extensive thick film fabrication capabilities. Our solutions range from providing boards for carrying very high levels of currents such as 100A applicable to high power applications, hybrid electronics, and covering frequencies from a few megahertz to 40 GHz. We specialize in low-volume, high-mix production and employ lean manufacturing to tailor to specific customer needs and enable flexibility, improved responsiveness, lower finished goods inventory, lower cost through efficient, and established processes. Remtec is also ITAR-compliant, with all product steps -- from conception to delivery -- performed domestically. We can take your designs/concept and to full production through our extensive thick film ceramics and metallization expertise.

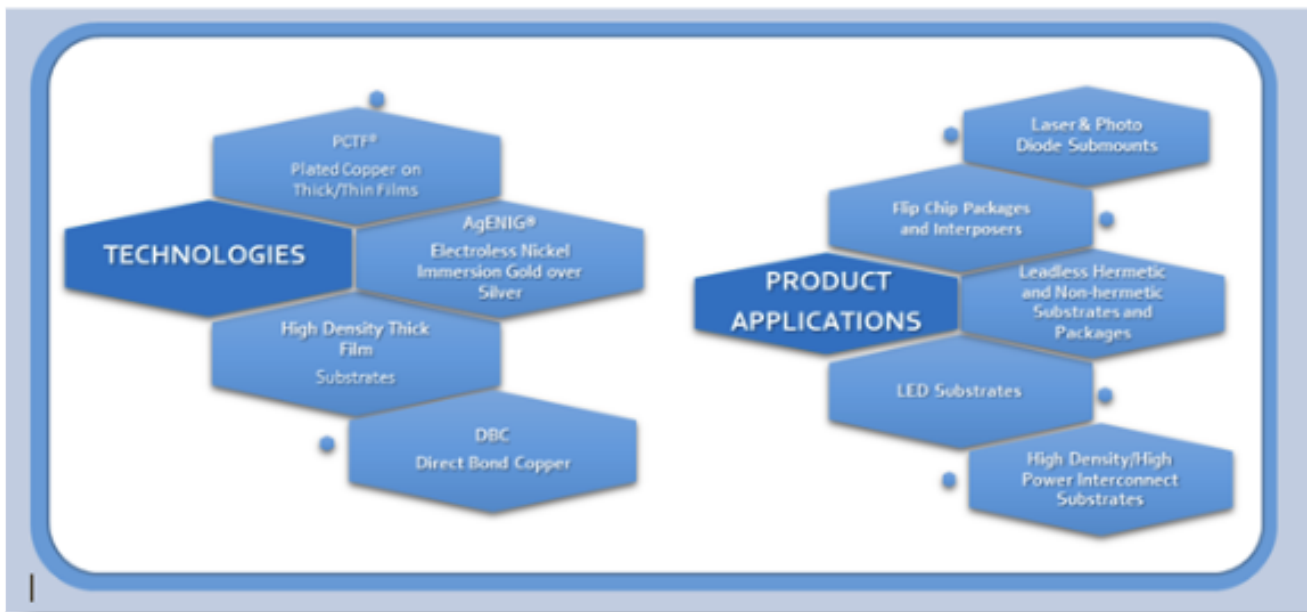


Figure 5: Thick film technologies and applications

Contact Remtec's sales & applications team for more information, product samples, or a thick-film feasibility study for your unique application/custom requirements.