

Low Temperature Co-fired Ceramics (LTCC) Multi-layer Module Boards



Example: Automotive Application

Example: Communication Application



*Innovator
in Electronics*

Murata
Manufacturing Co., Ltd.

Murata's Low Temperature Co-fired Ceramics offer highly integrated substrates for automotive modules and RF microwave circuits through a unique combination of ceramic materials and multi-layer/firing techniques.

LTCC, Low Temperature Co-fired Ceramic, is a multi-layer, glass ceramic substrate which is co-fired with low resistance metal conductors, such as Ag or Cu, at low firing temperatures (less than 1000°C). Sometimes it is referred to as "Glass Ceramics" because its main composition consists of glass and alumina.

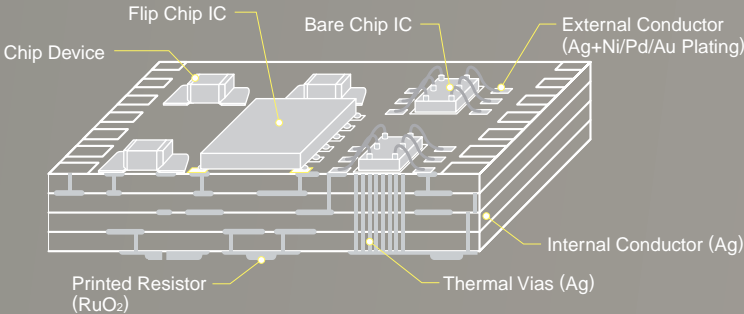
What makes Murata's LTCC special is our unique "Zero Shrinking Sintering Process" which restricts the ceramic shrinkage to only the z-direction (thickness). The ceramic retains its physical dimensions in the x and y direction. The process provides superb dimensional accuracy and surface flatness, even in large panel (8"x8") production.

Murata's "Zero Shrinkage LTCC" provides excellent electrical characteristics because of its use of low dielectric ceramic material and low resistance Ag conductors. The material is lead-free (Pb-free), cadmium-free (Cd-free), RoHS compliant, environment friendly, and offers good acid and alkaline durability, making it suitable for easy plating.

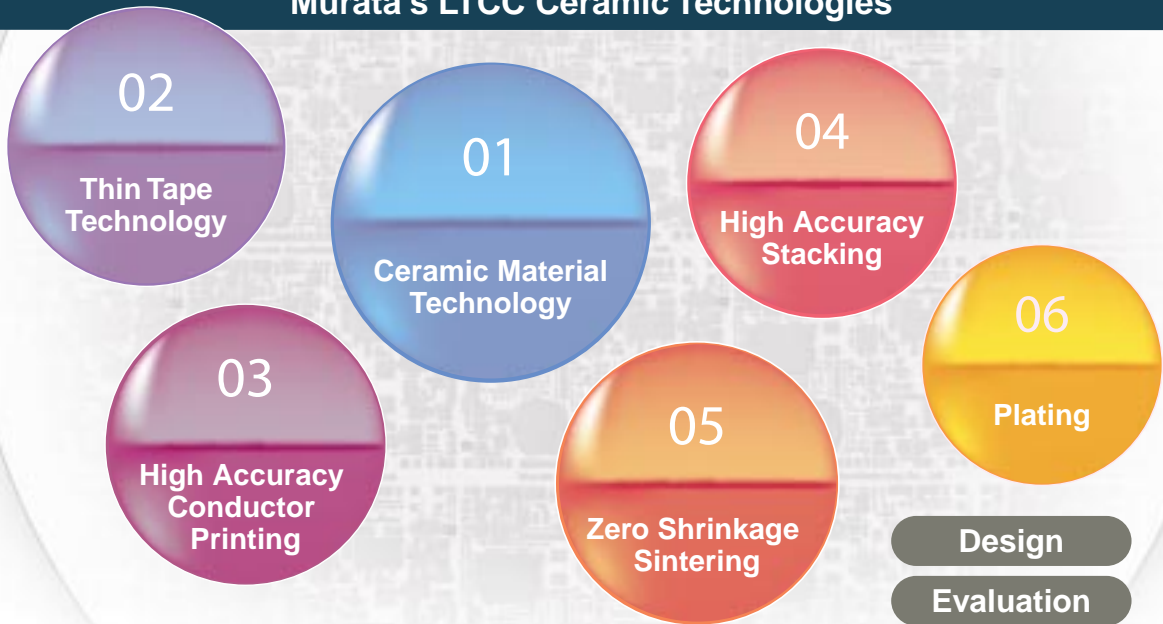
Murata's LTCC substrates are widely accepted in automotive applications for high reliability controller modules, as well as RF applications for high density small outline module substrates.

LTCC

Example Structure by LFC® series



Murata's LTCC Ceramic Technologies



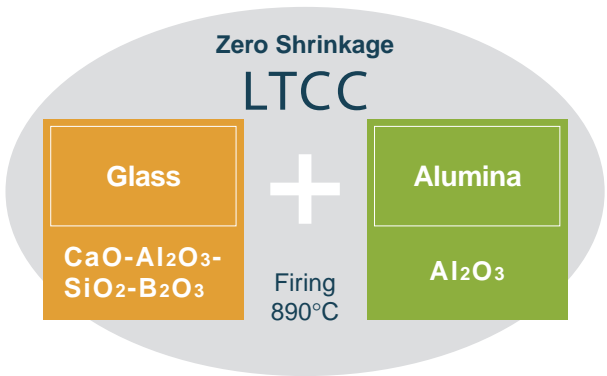
Ceramic Functional Substrates

Murata's LTCC substrates are co-fired with printed Ag conductor circuits at a relatively low temperature of 890°C. Murata's LTCC systems are Pb/Cd free and environment friendly.

Composition
Glass (CaO-Al₂O₃-SiO₂-B₂O₃) + Alumina (Al₂O₃)

- Feature**
- Low conductive resistance material is used for conductors.
 - In resistor printing with RuO₂ (Ruthenium Oxide) is available.
 - Electroless Chemical Plating with Ni/Pd/Au realizes high reliability conductors that minimize solder leaching.

* Cover Photo: Courtesy of Siemens VDO Automotive AG
* LFC® is a registered trademark of Murata Manufacturing Co., Ltd.



Murata's Zero-Shrinkage LTCC Series

Items	Units	for Substrates		
		LFC®	AWG	AWG+
Ceramic Compositions		CaO-Al ₂ O ₃ -SiO ₂ -B ₂ O ₃ +Al ₂ O ₃		
Conductor Material		Ag		
Bulk Density (Apparent Specific Gravity)	g/cm ³	2.9	3.2	3.2
Flexural Strength	Mpa	270	300	400
Thermal Expansion Co-efficient	ppm/°C	5.5	7.2	7.2
Dielectric Constant (at 1MHz)		7.7	8.8	15.1/8.8
Thermal Co-efficient of Dielectric Constant (TCC)	ppm/°C	≤ 110	150	150
Q		250 (6GHz)	240 (6GHz)	240 (6GHz)
Thermal Conductivity	W/m·K	2.5	3.5	3.5
Insulation Resistance between Layers	Ω	≥ 10 ¹⁰		
Break-down Volage	kV	≥ 5 (Layer Thickness 300μm)		

Murata proposes suitable material for your application.

Design Rules

Layer Thickness		12.5-200μm
Substrate Thickness		0.15-1.0mm
L/S	Surface Layers	100/100μm
	Inner Layers	75/75μm
Via	Diameter	100μm
	Pitch	300μm
	Via Pad Diameter	Surface 150-200μm Inner 150μm
Via Pad to Conductor Distance		125μm
Via Pad to GND Distance	Surface	150μm
	Inner	125μm
Substrate Edge to Via Center Distance		225μm
Substrate Edge to Conductor Edge Distance		150μm

LTCC Applications

Multi-Chip Modules for Automotive	High Frequency(RF) Modules	Others
ESC(ABS): Electronic Stability Control TCU: Transmission Control Unit EPS: Electronic Power Steering EMS: Engine Management System Various Sensor Modules	PAM: Power Amplifier Modules FEM: RF Front End Modules WiFi Modules GPS Modules UWB Modules	Camera Modules Small Outline Tuner Modules Other Thin Profile Modules for Devices and Components IC Tester Boards

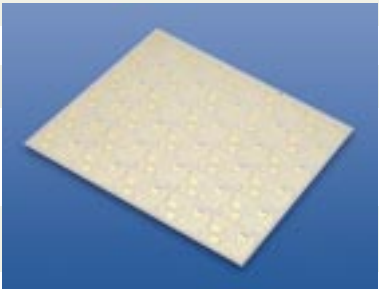
Certifications

• ISO9001:2000 Since 1994	• ISO14001:2004 Since 2005	• ISO/TS16949:2002 Since 2006
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Murata's LTCC Substrate Technology: LFC® Series

Murata's LFC® series LTCC substrate meets
high integration and miniaturization requirements
necessary for the automotive industry.

Features

Large panel production	202.0x202.0mm (effective layout area)	
High dimensional accuracy	±0.05%	
Excellent flatness	5μm/4mm SQ	
High reliability printed resistors	Ruthenium Oxide (RuO ₂) based ink resistors (accuracy ±1% max. [after trimming], TCR ±100ppm/°C, Sheet resistivity 10-300kΩ/SQ)	
Electro-less Ni/Pd/Au plating	Applicable to fine pitch wire bonding & Au bump flip-chip	
Embedded components	Small value capacitors and inductors can be embedded	

Pressure-assisted Zero-Shrinkage Sintering

Pressure-assisted Zero-Shrinkage Sintering Method

The exact pattern can be obtained after sintering
(No shrinkage in the panel area - shrinks in thickness only)

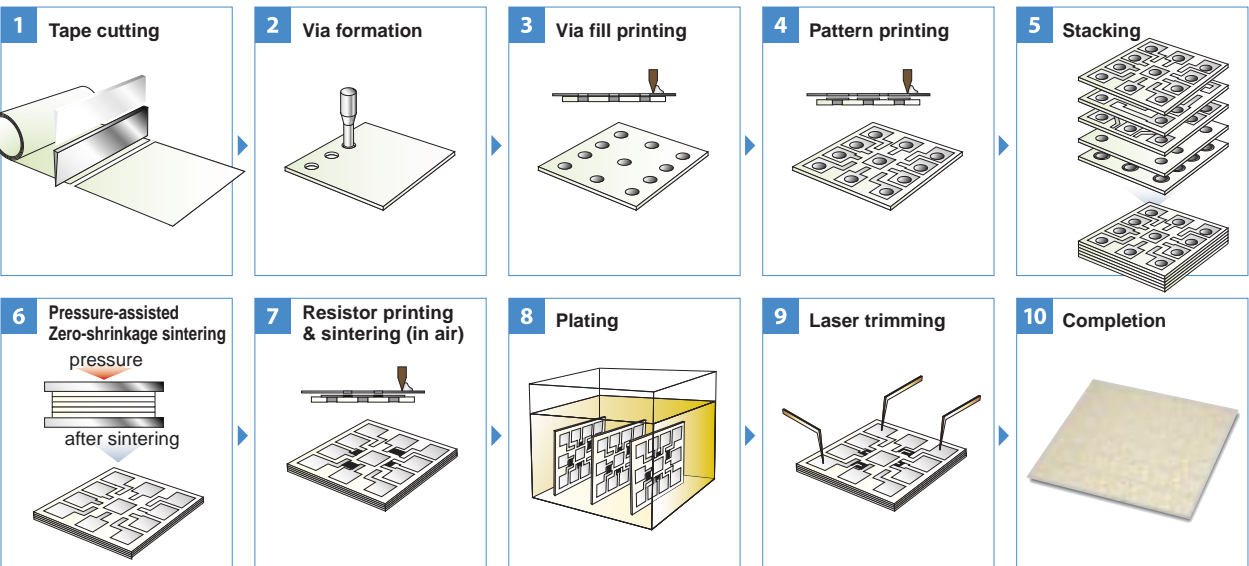
Dimensional accuracy: ±0.05%
Flatness : 5μm/4mm SQ
Sheet size : 202.0x202.0mm max.

Conventional Sintering Method

Approximately 20% shrinkage in length
(Almost 60% shrinkage from the original area)

Dimensional accuracy: ±0.5% at best
Flatness : Inner-layer undulation and surface waviness inevitable

LTCC (LFC®) Manufacturing Process



Down-sizing through Multi-layer Structure and Fine-line Patterning

Features

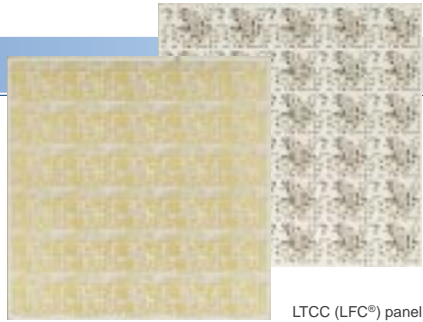
Multi-layer Structure Automotive Applications: 4 - 6 ceramic layers (5 - 7 conductor layers)
RF Applications: 10 - 25 ceramic layers

Excellent Board Flatness

Large panel, high dimensional accuracy process

Features

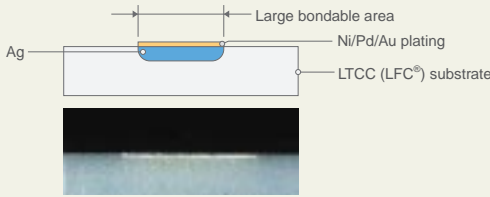
Large panel production : 202.0x202.0mm (effective layout area)
High dimensional accuracy: ±0.05% (dimensional tolerance of a panel)
Excellent flatness : 4mm SQ area ±5μm max. (including conductor thickness)



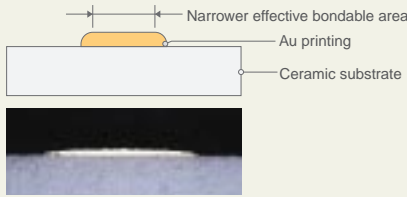
LTCC (LFC®) panel

Structure

Co-fired LTCC (LFC®) + Au plating



Post fired Au printing

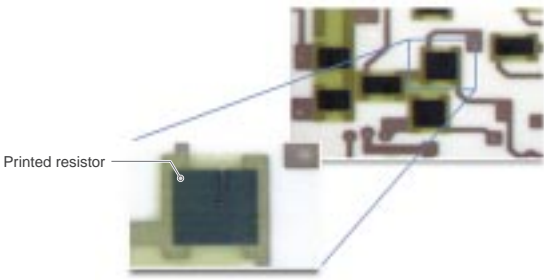


Pb/Cd-free Printed Resistor System

Printed Resistor HTF Series

Features

Resistance accuracy: ±1% max. (after trimming) | Pb/Cd free
TCR: ±100ppm/°C | Plating durability
Sheet resistivity: 10-300kΩ/SQ

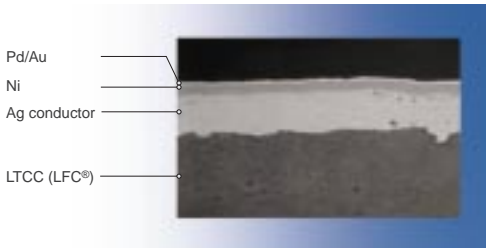


Electro-less (chemical) Plating

Chemical (electro-less) plating with ease - in mass production since 1996

Features

Ni/Pd/Au plating → High heat durable plating for wire-bonding



Murata's LTCC Substrate Technology: AWG Series

Utilized in low profile, small outline RF modules,
the **AWG** series features ultra thin ceramic tapes,
multiple material tape lamination and enhanced board strength.

Features

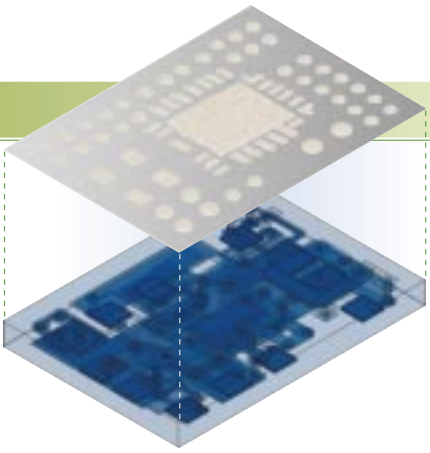
High density embedded RF passive functions	For smaller module requirements <ul style="list-style-type: none">• Ultra-thin tapes (12.5, 25, 50μm)• 2 different epsilon tapes ($\epsilon = 8.8, 15.1$)	
High dimensional accuracy	±0.1% Typ. (±0.2% guaranteed) <ul style="list-style-type: none">• Better assembly yield and cost reduction	
Thermal management	Thermal via formation	
Enhanced mechanical strength	Flexural strength: 400MPa min.	
Electro-less Ni/Au plating finish	Suitable for W/B and SMD mounting	
Design support	Customer support for specific design requirements	
Short prototype turn-around time	Prototype shipment in 10 days <ul style="list-style-type: none">• Quick turn-around time contributes to shorter development period	
Panel-by-panel RF Characteristics guarantee	Improvement of characteristics stability & product quality	

Embedded RF Functions

LTCC substrates can embed RF functions shown below.

Examples of embedded functions

Filters, couplers, balun, capacitors, inductors, striplines, etc.

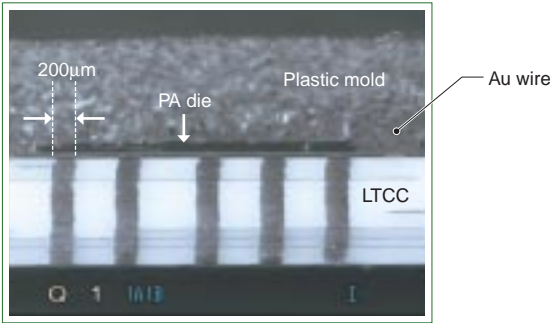


Thermal Management

With the help of the high density Ag conductor fill and high accuracy stacking method, vias are formed to enhance heat dissipation as well as electrical properties (ground).

Features

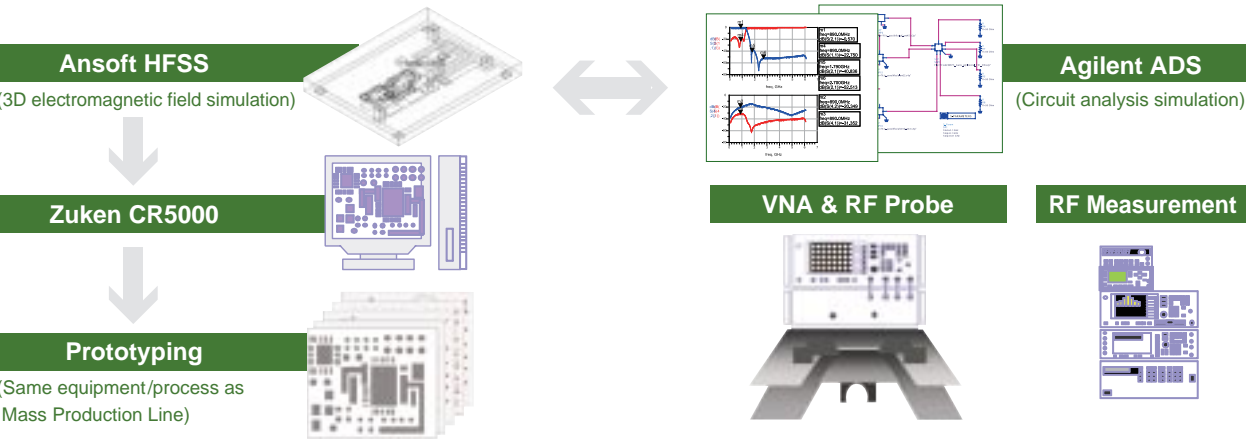
Die pad protrusion : 25μm max.
Thermal conductivity : 300W/m-K min.
Via diameter/pitch : 200μm/400μm



Cross Sectional View

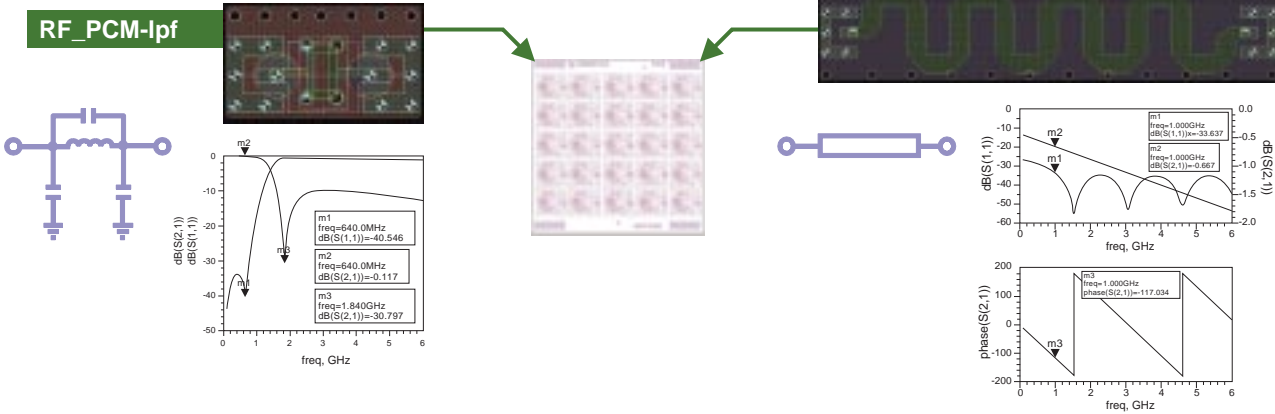
Design Support

Design support on pattern layouts, as well as the embedded functionalities, are available through CAD and various simulation systems.



RF Characteristics Guarantee

Test patterns are added on the dummy portion of the panel matrix to monitor the RF characteristics and quality of the LTCC module boards.



Example of a Smaller/Lower LTCC Module Board (GSM Quad Band TX Module)

By applying Murata's LTCC technology, as 8.55x8.45x0.40mm PCB substrate design can be reduced to 7.55x7.45x0.30mm with embedded LPF and Couplers (2 each).

Comparison of LTCC vs PCB Module boards

LTCC

7.55x7.45x0.30mm

Embedded functions in LTCC

1. Tx2 2nd stage - LPF
2. Tx2 Coupler
3. Tx1 2nd stage - LPF
4. Tx1 Coupler



PCB

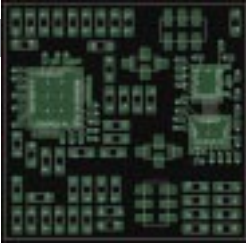
8.55x8.45x0.40mm

Mounted components on PCB

- Coupler (High band): 1.6x0.8x0.6mm
- LPF (High band): 1.0x0.5x0.4mm
- LPF (Low band): 1.0x0.5x0.4mm
- Coupler (Low band): 1.6x0.8x0.6mm



PCB - cross section view



⚠ **Note:**

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- | | |
|-----------------------------|--|
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