N20E.pdf
Jan.22,2014

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

Example: Automotive Application

Example: Communication Application

muRata Innovator in Electronics

Murata
Manufacturing Co., Ltd.

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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.

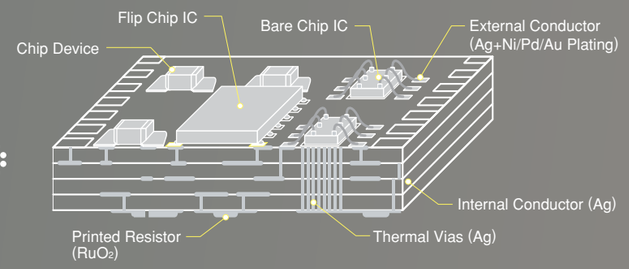
What makes Murata's LTCC special is our unique "Zero Shrinking Sintering Process" which restricts the ceramic shrinkage to only the z-direction (thickness). The ceramic retains it physical dimensions in the x and y direction. The process provides superb dimensional accuracy and surface flatness, even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



Ceramic Functional Substrates

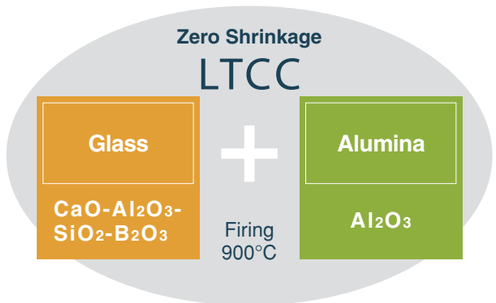
Murata's LTCC substrates are co-fired with printed Ag conductor circuits at a relatively low temperature of 900°C. Murata's LTCC systems are Pb/Cd free and environment friendly.

Composition

Glass ($CaO-Al_2O_3-SiO_2-B_2O_3$) + Alumina (Al_2O_3)

Feature

- Low conductive resistance material is used for conductors.
- In resistor printing with RuO_2 (Ruthenium Oxide) is available.
- Electroless Chemical Plating with Ni/Pd/Au realizes high reliability conductors that minimize solder leaching.



∗ Cover Photo: Courtesy of Continental Automotive AG

∗ LFC® is a registered trademark of Murata Manufacturing Co., Ltd.

Murata's Zero-Shrinkage LTCC Series

Items	Units	for Substrates		
		LFC®	AWG	SWG
Ceramic Compositions		$CaO-Al_2O_3-SiO_2-B_2O_3+Al_2O_3$		
Conductor Material		Ag		
Bulk Density (Apparent Specific Gravity)	g/cm^3	2.9	3.2	3.2
Flexural Strength	Mpa	270	300	450
Substrate Thickness (Typ.)	mm	0.4 to 6.0	0.3 to 1.0	0.1 to 0.35
Thermal Expansion Co-efficient	ppm/°C	5.5	7.2	7.2
Dielectric Constant (at 1MHz)		7.7	8.8	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			12.5-160μm
L/S	Surface Layers		100/100μm
	Inner Layers		75/75μm
Via	Diameter		100μm
	Pitch		250μm
	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

TCU: Transmission Control Unit
EPS: Electronic Power Steering
ESC(ABS): Electronic Stability Control
EMS: Engine Management System
Various Sensor Modules
Radar Modules
Pressure Sensor

High Frequency(RF) Modules

PAM: Power Amplifier Modules
FEM: RF Front End Modules
WiMAX2 Modules
LTE-advanced Modules

Others

Camera Modules
Small Outline Tuner Modules
Other Thin Profile Modules for Devices and Components
IC Tester Boards

Certifications

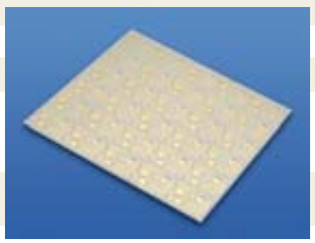
ISO9001:2000	ISO14001:2004	ISO/TS16949:2002
Since 1994	Since 2005	Since 2006

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 20-300kΩ/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)

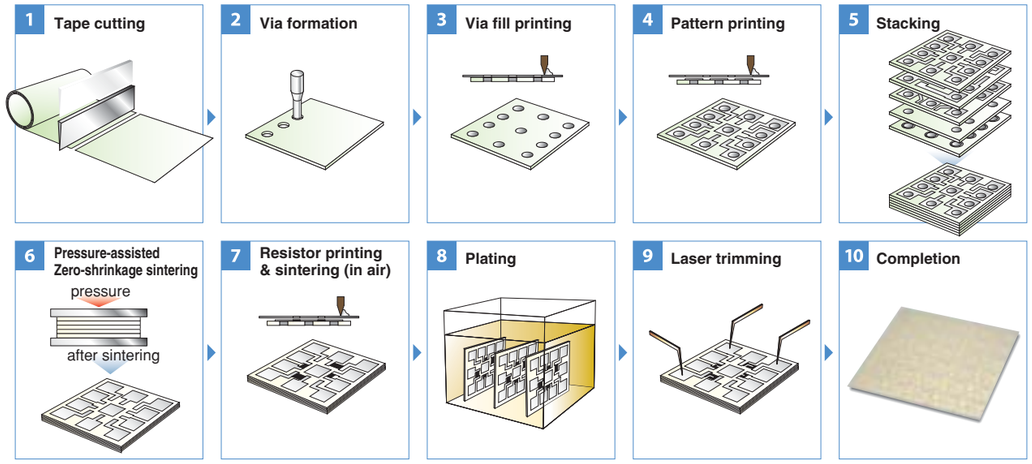
Dimensional accuracy: ±0.05%
Flatness : 5μm/4mm SQ
Panel size : 202.0x202.0mm max.

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



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

Features

Multi-layer Structure Automotive Applications: 4 - 6 ceramic layers
RF Applications: 10 - 25 ceramic layers
Others Wiring Substrate: 5 - 8 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

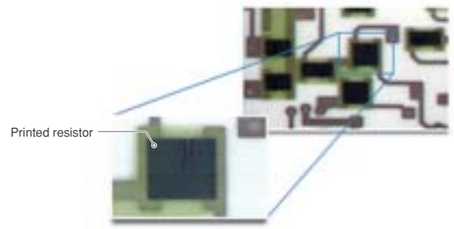
Pb/Cd-free Printed Resistor System

Printed Resistor HTF Series

Features

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

Pb/Cd free
Plating durability

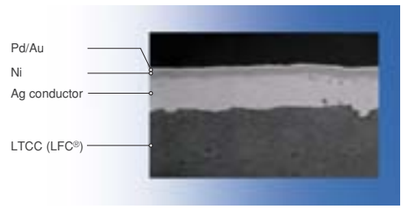


Electro-less (chemical) Plating

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

Features

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

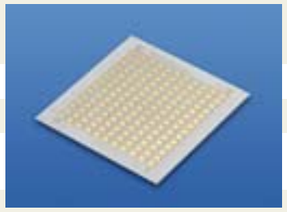


Murata's LTCC Substrate Technology: AWG/SWG Series

Utilized in low profile, small outline RF modules, the AWG/SWG 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 • Ultra-thin tapes (12.5, 25, 50μm) • 2 different epsilon tapes (ε = 8.8, 15.1)
High dimensional accuracy	±0.1% Typ. (±0.2% guaranteed)
Thermal management	Thermal via formation
Enhanced mechanical strength	Flexural strength: AWG 400MPa min. SWG 450MPa 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
Panel-by-panel RF Characteristics guarantee	Improvement of characteristics stability & product quality

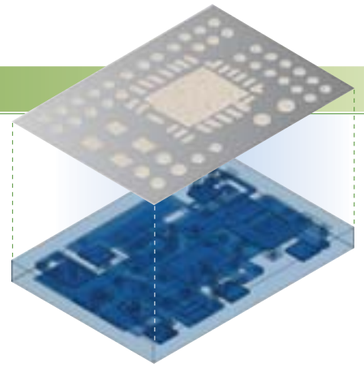


Embedded RF Functions

LTCC substrates can embed RF functions shown below.

Examples of embedded functions

Filters, couplers, balun, capacitors (to 100pF), inductors (to 100nH) etc.

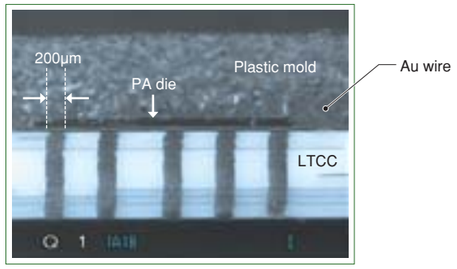


Thermal Management

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.



Cross Sectional View

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Design Support

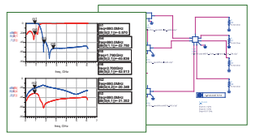
Design support on pattern layouts, as well as the embedded functionalities, are available through CAD and various simulation systems.

Femtet® (Made by Murata)

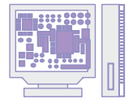
(3D electromagnetic field simulation)

Agilent ADS

(Circuit analysis simulation)



Zuken CR5000

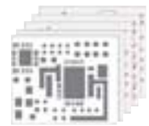


VNA & RF Probe

RF Measurement

Prototyping

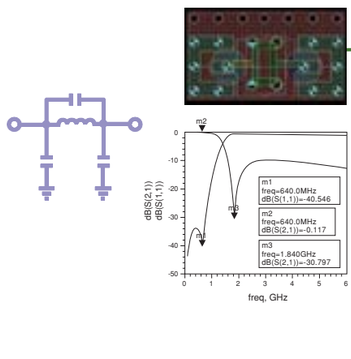
(Same equipment/process as Mass Production Line)



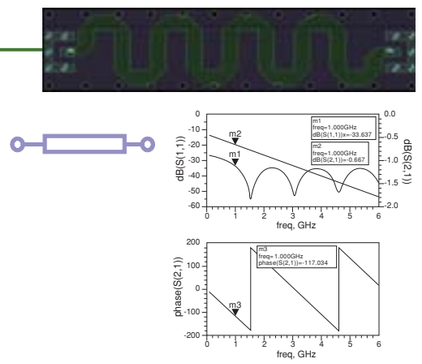
RF Characteristics Guarantee

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

RF_PCM-lpf



RF_PCM-ms



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muRata Murata Manufacturing Co., Ltd.

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Head Office
1-10-1, Higashi Kotari, Nagaokakyo-shi, Kyoto 617-8555, Japan
Phone: 81-75-951-9111

International Division
3-29-12, Shibuya, Shibuya-ku, Tokyo 150-0002, Japan
Phone: 81-3-5469-6123 Fax: 81-3-5469-6155 E-mail: intl@murata.co.jp

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