



# C12 Advanced Technologies

**C12 Carbon Paste products** are made with specially processed, ultra-pure carbon. C12 “thermally fugitive” Carbon Pastes are used to form embedded channels, cavities, and MEMs structures in multilayer ceramics such as LTCC and HTCC substrates. C12 Carbon Pastes have the highest solids loading available, which results in very low shrinkage and crack-free prints. Other thermally fugitive pastes and materials with lower carbon loading and excessive binder content often cause stress, warping, and damage to delicate structures during firing. C12 Carbon Pastes are designed to be compatible with all major commercial LTCC tape and screen printable systems.

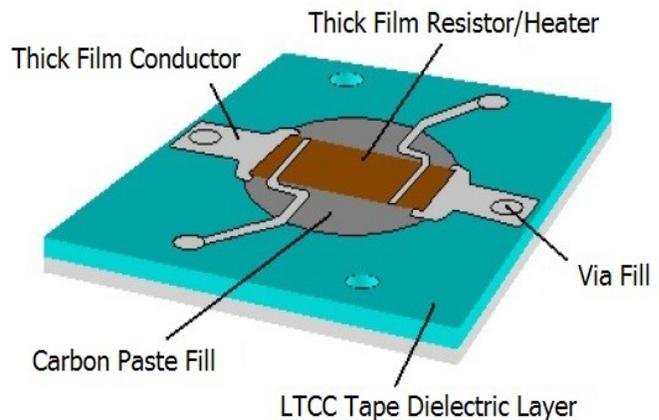
Ultra-pure C12 Carbon Pastes are engineered to burn out cleanly in air atmospheres. C12 Carbon Pastes begin to rapidly oxidize at 600C, just as the LTCC ceramic matrix sinters, leaving behind well-defined features such as cavities and channels. C12 Carbon Pastes create precise, stress-free structures, unlike conventional fugitive materials such as waxes and polymers, which often leave residue and result in stress related deformation. C12 Carbon Pastes can also be a cost effective alternative to using removable inserts such as platinum or latex for creating structural features.

## Benefits

- Forms clean embedded channels, cavities, and MEMs structures.
- *Highest available carbon loading – allows very low shrinkage and thick, crack-free prints.*
- Prevents deformation and damage of internal structures during high pressure lamination. Replaces removable inserts.
- Prevents slumping through binder burnout and up to onset of pore closure during sintering.
- Contains ultra-high purity carbon which burns out cleanly (converts directly to gas) without causing stress on green parts.
- Does not require complex lamination or firing cycles like other polymeric fugitive materials.
- Compatible with all major commercial LTCC tape and screen printable systems.

## Printing and Lamination

C12 Carbon Pastes can be dispensed or screen printed in single layers that are up to 0.010 inches thick. C12 Carbon Paste is fully compatible with most commercially available thick film paste systems and can be co-laminated with ceramic tapes in accordance with conventional LTCC procedures (typically 70C for 10 min at a pressure of 3000 psi).



**Figure 1. Design for a “thermally isolated” micro-hotplate in a ceramic (LTCC) substrate. Suspended bridge structure is printed on top of cavity filled with thermally fugitive C12 Carbon Paste.**

## Firing

C12 Carbon Paste must be fired in an air (oxygen) atmosphere in order for complete oxidation and burn-out to occur. C12 Carbon Pastes contain a minimal amount of binder that burns out at approximately 325-450C, and will not interfere with the sintering of most LTCC tape systems. Rapid oxidation of ultra high purity C12 Carbon Paste occurs at temperatures approaching 600C, as shown in Figure 2. The required time to complete burn-out will depend on heating rate, holding time, temperature, volume of carbon, and the oxygen content of the furnace atmosphere.

The sample firing schedule in Figure 3 can be used to create distortion free micro-channels and buried cavities in LTCC multilayers. The firing profile consists of 3 steps; the first plateau at 450C for 60 min allows organic binder components to burn out, the next plateau at 710C for 60 min allows all residual carbon to



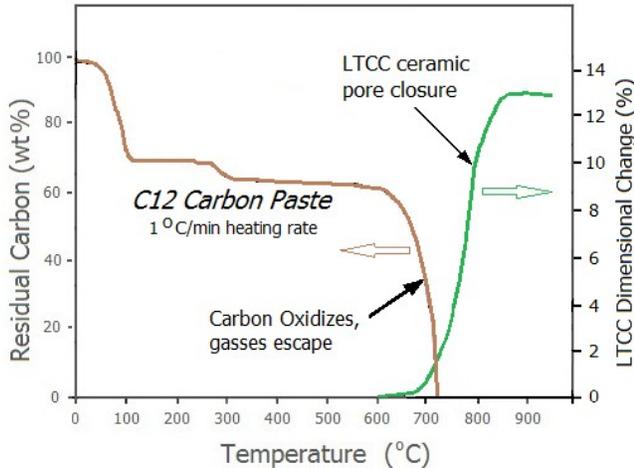
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completely burn out, just before LTCC pore closure, and finally, viscous sintering of the LTCC multilayer takes place during the the last plateau at 850C which is held for about 15 min.

attention if irritation develops.

## Storage and Shelf Life

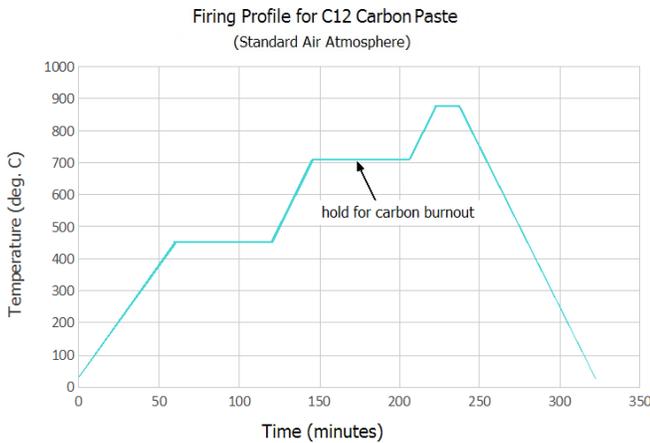
C12 Carbon Pastes are available in resealable jars and syringes. C12 carbon Pastes should be stored, tightly sealed, in a clean, stable environment at room temperature (<25°C). C12 Carbon Pastes can be stored for at least 1 year.



**Figure 2. C12 Carbon Pastes begin rapid burn-out (oxidation) in air just before pore closure begins in LTCC ceramic (DP951 Green Tape).**



**Figure 4. C12 Carbon Pastes are available in resealable jars and syringes for dispensing.**



**Figure 3. Recommended firing schedule for creating defect-free microchannels and buried cavities in LTCC multilayers.**

## Clean-up

Excess Carbon Paste can be removed from equipment surfaces with isopropyl alcohol (IPA) or ethanol. As with most screen-printable thick film pastes, skin contact with C12 Carbon Pastes should be avoided, and user should wear protective gloves. Wash thoroughly with mild soap and water. Seek medical



**Figure 5. Cross section showing buried microchannels formed in LTCC laminates with thermally fugitive C12 Carbon paste (approx. 40um).**

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