



# C12 Advanced Technologies

**C12 Carbon Tapes** are thin flexible sheets made with specially processed, ultra-pure carbon. C12 “thermally fugitive” Carbon Tapes are used to form embedded channels, cavities, and MEMs structures in multilayer ceramics such as LTCC and HTCC substrates. C12 Carbon Tapes have the highest solids loading available, which results in very low sagging and crack-free laminates after firing. 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 Tapes can be a cost effective alternative to using removable inserts such as platinum or latex to create structural features. C12 Carbon Tapes do not smudge, and are easily punched or cut into complex shapes with simple tools or with low-power laser trimmers. C12 Carbon Tapes are designed to be compatible with all major commercial LTCC tape and screen printable systems.

Ultra-pure C12 Carbon Tapes are engineered to burn out cleanly in air atmospheres. C12 Carbon Tapes 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 Tapes create precise, stress-free structures, unlike conventional fugitive materials such as waxes and polymers, which often leave residue and result in stress related deformation.

## Benefits

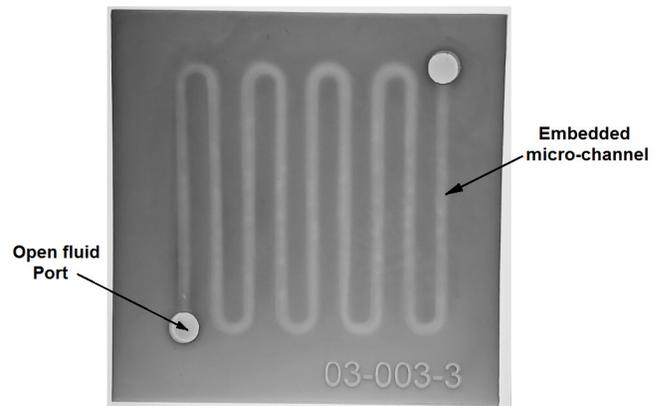
- Forms clean embedded channels, cavities, and MEMs structures.
- *Highest available carbon loading – provides lowest sagging and crack-free laminates.*
- Prevents deformation and damage of internal structures during high pressure lamination. Replaces removable inserts (latex rubber, etc.)
- Prevents 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.

## Cutting and Punching Methods

C12 Carbon Tapes can be punched, laser cut, etched, and micro-machined to meet exacting design requirements. C12 Carbon Tape is provided with a 0.003 inch Mylar release backing, which can be removed prior to punching or cutting.

## Lamination

C12 Carbon Tapes can be laminated (uni-axial or isostatic) in order to achieve a desired thickness. C12 Carbon Tapes can be laminated prior to insertion, or during co-lamination with ceramic tapes, in accordance with conventional procedures (typically 70C for 10 min at a pressure of 3000 psi). Specific lamination parameters will vary depending on final laminate thickness and the ceramic tape system being used.



**Figure 1. Multilayer ceramic (Al<sub>2</sub>O<sub>3</sub>) substrate with embedded cooling channels and ports formed using thermally fugitive C12 Carbon Tape inserts.**

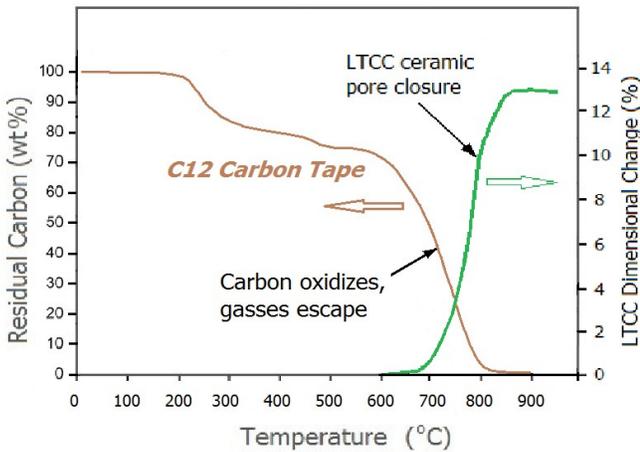
## Firing

C12 Carbon Tapes must be fired in an air (oxygen) atmosphere in order for complete oxidation to occur. C12 Carbon Tapes contain a minimal amount of binder that burns out at approximately 325-450C, and will not interfere with the sintering of most commercially available LTCC tape systems. Rapid oxidation of ultra high purity C12 Carbon Tape 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 firing schedule in Figure 3 can be used to create distortion free micro-channels and buried cavities in LTCC

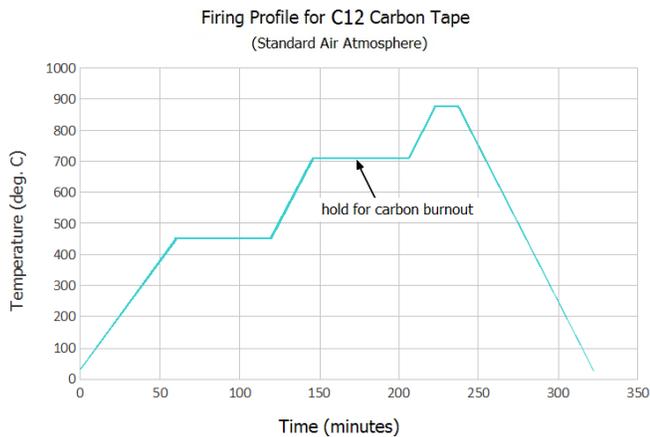


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multilayers. The firing profile consists of 3 steps; the first plateau at 450C for 60 min allows organic binder components to burn out, the next plateau at 710C for 60 min allows all residual carbon to completely burn out, just before LTCC pore closure, and finally, viscous sintering of the LTCC multilayer takes place during the the last plateau at 850C which is held for about 15 min.



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



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

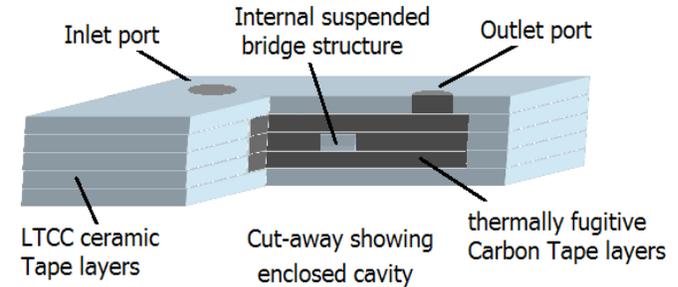
### Clean-up

C12 Carbon Tapes are soluble in isopropyl alcohol (IPA) and ethanol. C12 Carbon Tapes are not likely to be hazardous by skin contact due to low levels of potential irritants, however the user should avoid

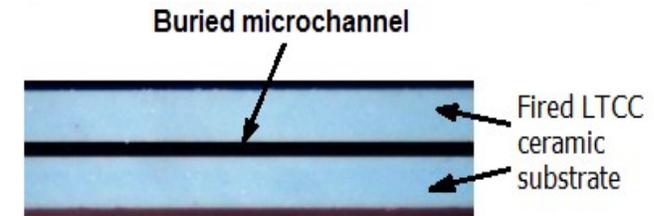
intimate skin contact. Wash thoroughly with mild soap and water. Seek medical attention if irritation develops.

### Storage and Shelf Life

C12 Carbon Tapes in sheet and roll form should be stored in tightly sealed containers or bags in a clean, dry atmosphere at room temperature. C12 Carbon Tapes can be stored for at least 2 years.



**Figure 4. Design for a ceramic (LTCC) multilayer with suspended bridge for flow sensing. Channels and bridges are created with thermally fugitive C12 Carbon Tapes.**



**Figure 5. Cross section showing buried microchannels formed in LTCC laminate with thermally fugitive C12 Carbon Tape (approx. 130um).**

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