

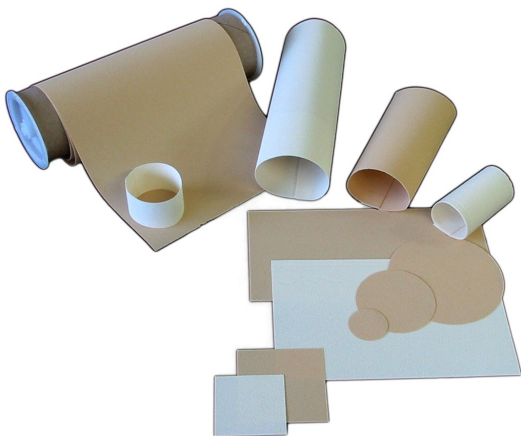
# C12 Advanced Technologies

## Separator Powder Sheets <sup>TM</sup>

*Providing a uniform distribution of setter powders  
to eliminate distortion, sticking, and cracking.*

### Description

**C12 Separator Powder Sheets (SPS)** are an effective, low-cost solution for eliminating problems with sticking, cracking, and warping that make firing delicate green forms and sinterable components challenging. C12 SPS Sheets contain high purity, specially-processed ceramic particles in a proprietary binder that is engineered to burn out cleanly at low temperatures, allowing the green forms to fire without defects. A thin, highly uniform layer of inert refractory particles is deposited between the surface of the setter plate and the parts that are being fired. This inert layer of particles resists sintering, and provides an anti-friction surface that allows for shrinkage of green parts with minimal stress, sticking, and distortion.



Thin, flexible **C12 Separator Powder Sheets (SPS)** are ideal for eliminating difficult problems with cracking and sticking. C12 SPS Sheets are available in various standard grades, sizes, and compositions.

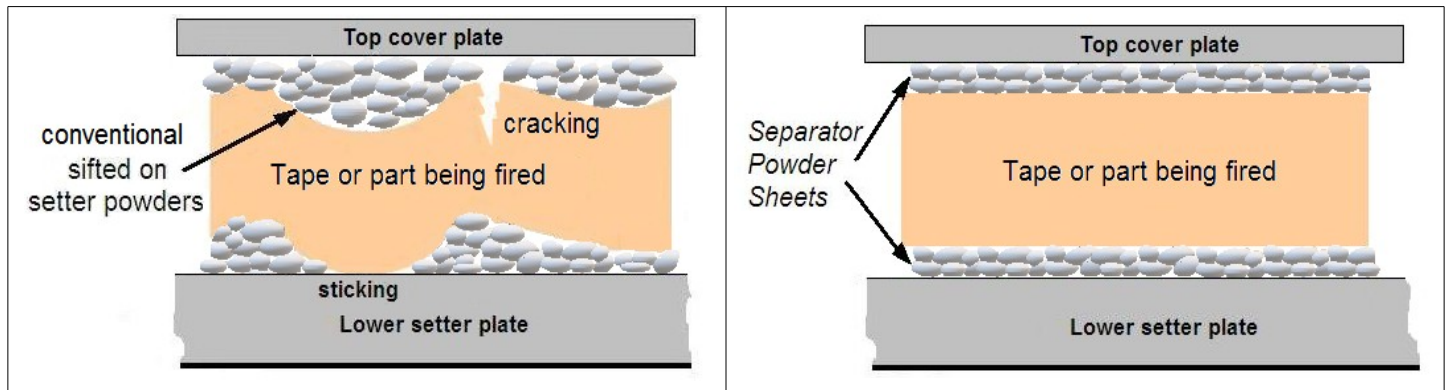
Thin, flexible SPS Sheets are available in a convenient range of compositions and particle-size grades that have been extensively tested and optimized. Lighter-grade SPS sheets are ideal for tapecast ceramics, parts that require very smooth surfaces, and other delicate components. Heavier-grade SPS Sheets are ideal for high value parts that require low distortion firing, such as piezoceramic disks, SOFC electrolytes, and for powder metallurgy (MIM) parts.

SPS Sheets can greatly improve surface quality, and in some cases, lapping and polishing steps can actually be eliminated. SPS Sheets can be easily inserted between stacked parts allowing greater kiln efficiency and lower firing costs. SPS Sheets also reduce labor costs and clean-up issues associated with sifting on setter sands or applying wash coats, and can help prolong the life of expensive setter plates by reducing contamination.

### Applications

Cracking, sticking, and distortion often occur during the firing of technical ceramic and powder metal products, particularly with tapecast forms and other thin or fragile parts. Additionally, many parts containing volatile or low melting components, such as Pb, also have significant problems with out-diffusion and contamination. A variety of approaches have been developed in an attempt to solve these problems, however no solution has been completely satisfactory until now.

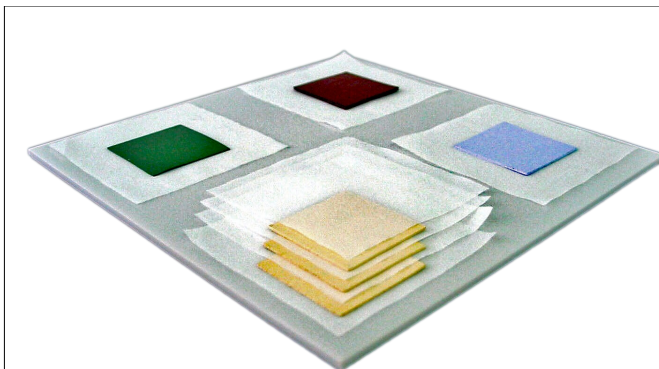
Typical approaches that are used to reduce cracking and sticking problems usually involve coating the un-fired green part with loose ceramic powders, or “setter powders”, by means of sifting, rubbing and/or brushing on the powders. A significant problem with this method is that it is very hard to disperse the setter powders uniformly, which in turn leads to sticking, cracking, “setter drag”, and other defects. The use of loose setter powders also tends to be inherently slow and labor intensive, resulting in lower efficiencies and higher costs. Figure 2a illustrates some of the problems associated with using conventional sifted or brushed-on setter powders, and Figure 2b shows how SPS Sheets can solve these problems.



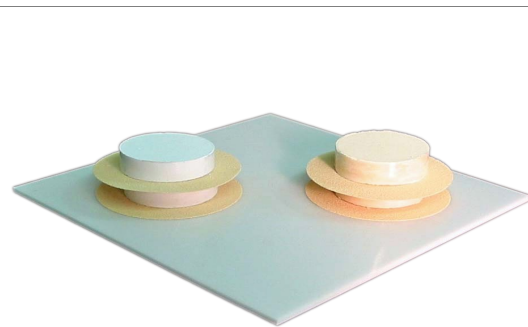
**Figure 2a.** Conventional setter powders are typically brushed or sifted onto parts before firing. Cracks, deformation, and sticking often result because it is very difficult to distribute powders evenly.

**Figure 2b.** Specially-processed, inert ceramic powders are deposited in thin, highly uniform layers with **SPS Sheets**. After firing, parts are flat, crack-free and have superior surface quality.

C12 Separator Powder Sheets were developed to meet the need for an improved, low cost way to eliminate the problems that stem from using conventional setter powders and typical application methods. Figures 3a and 3b below show some examples of how SPS Sheets are commonly used to improve firing and sintering with several types of technical ceramics, and how the SPS Sheets are optimized for different requirements. Figure 3a (left) shows examples of thin ceramic tapes stacked together with light-grade SPS Sheets inserted between each tape prior to firing. Figure 3b (right) is a similar example, but with medium-sized ceramic discs and heavier-grade SPS Sheets inserted between each disc. SPS Sheets are uniquely useful in these applications for creating a protective, anti-friction layer that helps prevent sticking when green parts shrink and densify at high temperatures.

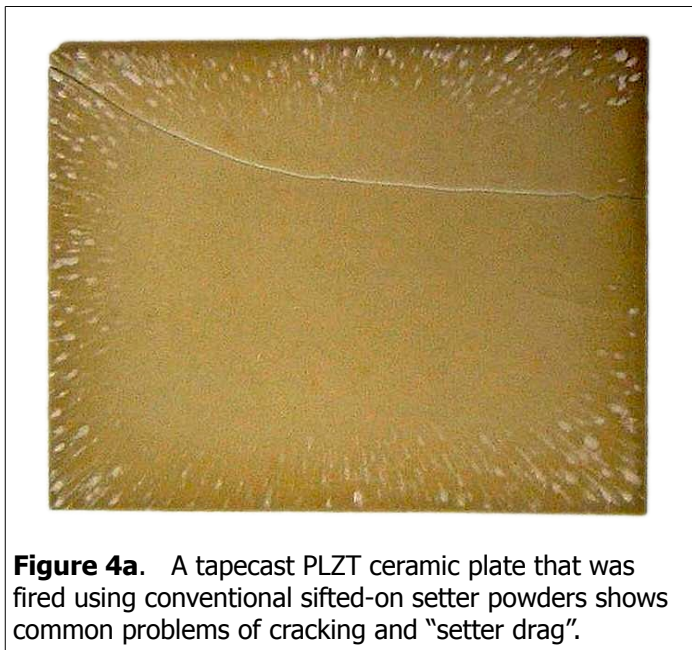


**Figure 3a.** Stack of thin ceramic tapes with light-grade **SPS Sheets** inserted between each tape prior to firing.

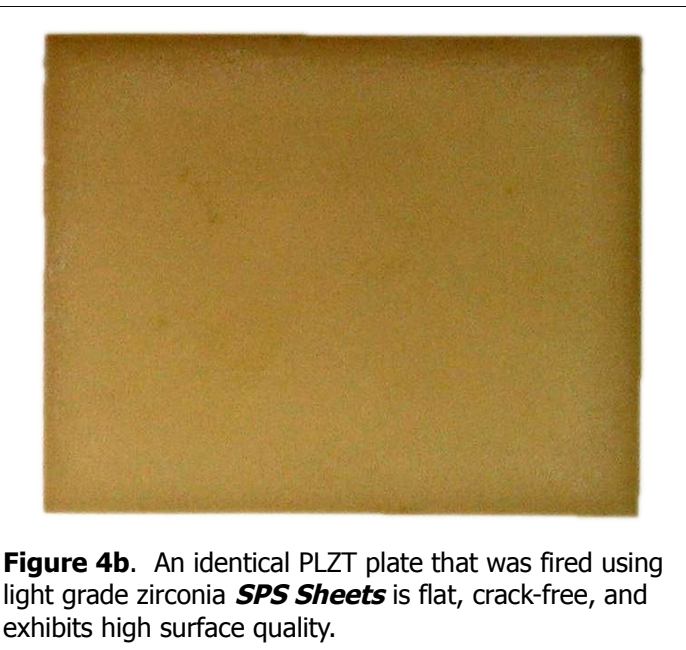


**Figure 3b.** Larger or heavier ceramic discs can be stacked with medium-grade **SPS Sheets** inserted between each disc prior to firing.

Even thin plates and compacts, that are particularly difficult to fire because they have glassy, volatile, or low melting phases, can be fired successfully with C12 SPS Sheets. Figure 4a (left) shows a tape-cast PLZT ceramic plate that was fired using conventional sifted-on setter powders, and the dramatic improvement in Figure 4b (right) when an identical PLZT plate was fired using light grade zirconia SPS Sheet.



**Figure 4a.** A tapecast PLZT ceramic plate that was fired using conventional sifted-on setter powders shows common problems of cracking and “setter drag”.



**Figure 4b.** An identical PLZT plate that was fired using light grade zirconia **SPS Sheets** is flat, crack-free, and exhibits high surface quality.

Standard SPS Sheets contain high-purity zirconia, magnesia, or alumina refractory powders that are specially processed and tested to insure compatibility with many advanced technical products including PZT/PLZT piezoceramics, fuel cells, Low Temperature Co-fired Ceramics (LTCC), powdered metallurgy products, capacitors, ferrites, superconductors, glass ceramics and other composite articles.

<b>Table 1. Selection Guide for Separator Powder Sheet (SPS) Products.</b>		
Note: Standard Sheet size is 4 inch X 8 inch (100 X 200mm). Custom sizes and rolls are available upon request.		
Type	Description and Applications	Sheet Thickness
<b>SPS-AL-F</b>	Low solids grade aluminum oxide powder sheets. Specifically designed to protect precious metal thick film traces from damage during sintering. Typically used for firing thin LTCC laminates, oxygen sensors, and delicate alumina-based components.	0.001 inch (25.4 μm)
<b>SPS-AL-MA2UG</b>	Medium grade aluminum oxide powder sheets. Typically used for firing small to medium size alumina plates, alumina-based components, and LTCC or HTCC laminates with thick film electronics. Recommended for stack firing.	0.005 inch (127 μm)
<b>SPS-MG-M200</b>	Medium grade magnesium oxide powder sheets. Typically used for firing SOFC fuel cells, LTCC, PZT/PLZT piezoceramics, electrolytes, and other small to medium size magnesia-based components. Recommended for stack firing.	0.003 inch (76 μm)
<b>SPS-ZR-F</b>	Low solids grade zirconium oxide powder sheets. Typically used for firing small size PZT/PLZT piezoceramics and other delicate zirconia-based components.	0.002 inch (51 μm)
<b>SPS-ZR-M</b>	Medium grade zirconium oxide powder sheets. Typically used for firing SOFC fuel cells, small to medium size PZT/PLZT piezoceramics, and other zirconia-based components. Recommended for stack firing and HIP pressing.	0.008 inch (203 μm)
<b>SPS-ZR-C</b>	Coarse grade zirconium oxide powder sheets. Typically used for firing larger size PZT/PLZT piezoceramics and other zirconia-based components. Recommended for stack firing and HIP pressing.	0.018 inch (457 μm)

**C12 Separator Powder Sheets** can be formulated with customer-supplied powders for a minimal charge.

The Selection Guide in Table 1 (above) can be used to determine the best type and grade of standard SPS Sheet for a particular application. SPS Sheets can also be formulated with customer-supplied powders or custom compositions upon request.

**C12 Separator Powder Sheet** advantages include:

- Reduces labor costs associated with applying sands and powders.
- Eliminates sticking, “setter drag”, and cracking of fragile parts during firing.
- Allows for stacking of ceramic parts, maximizing furnace capacity and efficiency.
- Improves yields and quality, parts are flat and distortion-free.
- Reduces lead loss in PLZT and PZT piezoceramics.
- Reduces contamination and prolongs life of setter plates.
- Allows use of weighted cover plates to prevent warping.

### Binder burnout properties

The proprietary organic binder in C12 SPS Sheets is formulated so that it has a burnout temperature that is significantly lower than most commercial binders that are used to form green ceramic parts and sinterable components. Sensitive or fragile green parts are able to maintain their strength as the proprietary binder in the SPS Sheets burns out cleanly, and without creating stress on the green parts. The organic binders and the powder loading in SPS Sheets has been optimized for minimal shrinkage and contraction before and during the binder burnout process. Figure 5 shows TGA curves for the proprietary binder used in SPS Sheets compared with PVB and PVA, (binders commonly used in green ceramic forming and tapecasting). The onset burnout temperature for the SPS proprietary binder is approximately 250 °C. Over 70 weight percent of the SPS binder has burned out before the onset burnout temperature of PVB (about 300 °C) and PVA (about 325 °C) binders. Binders and other materials used in SPS Sheets also have the advantages of high strength, environmental safety and low toxicity.

