

C12 Advanced Technologies, LLC

3101 111th Street SW, Suite R, Everett, WA 98204

Phone: (206) 795-8925 • www.C12Materials.com • info@C12Materials.com

Separator Powder Sheets TM

Provides uniform distribution of setter powders that eliminates distortion, sticking, and cracking during firing or sintering.

Description

C12 Advanced Technologies now offers Separator Powder Sheets (SPS); a low-cost, effective solution for eliminating the most difficult sticking, cracking, and warping problems that often make firing green ceramics and other sensitive components a challenging task. SPS Sheets contain high purity, specially-processed refractory ceramic particles and a proprietary binder, which burns out cleanly at lower temperatures, *before* the binders that are typically used in pressed, tapecast or compacted green ceramic parts. The result is a thin, highly uniform layer of inert refractory particles that is deposited between the surface of the setter plate, or contact surfaces, and the parts being fired. This uniform layer of inert particles resists sintering and provides an anti-friction, "ball bearing" action that allows for shrinkage of green parts with minimal stress, sticking, or distortion during sintering.

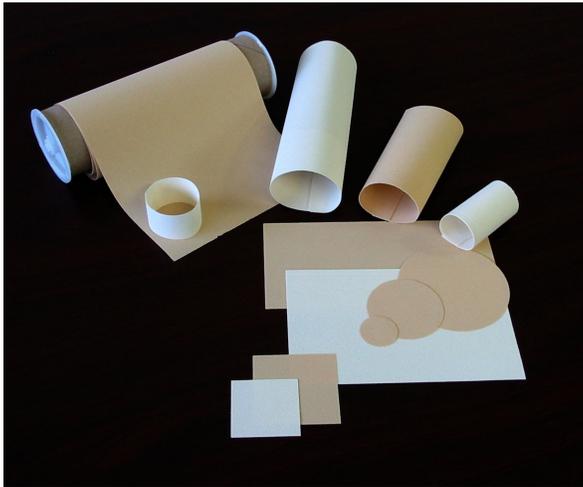


Figure 1. Thin, flexible **Separator Powder (SPS) Sheets** are available in various sizes, grades, and powder compositions for eliminating difficult problems with cracking and sticking during firing or sintering.

Thin, flexible SPS Sheets are available in a convenient range of thicknesses 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 firing parts such as medium to large-sized pressed piezoceramic disks, larger SOFC plates, and for heavier flat stacking applications.

SPS Sheets can greatly improve surface quality over conventional processes, and in some cases, lapping and polishing steps can actually be eliminated. Multiple SPS Sheets can also be easily inserted between stacked parts allowing greater kiln efficiencies and lower firing costs. SPS Sheets 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, warping, and surface deterioration often occur during firing of technical ceramics, particularly with tapecast plates 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 applied in an attempt to solve these problems, however, no solution has been completely satisfactory.

Typical approaches that are used to reduce cracking and sticking problems usually involve coating the green ceramic part with suitable refractory ceramic powders, or “setter powders”, by means of sprinkling, sifting, rubbing and/or brushing on the powders. A significant problem with this method is that it is very hard to avoid dispersing the setter powders without non-uniformities, which in turn lead to surface deformations and other defects. The use of loose setter powders during the firing process also tends to be inherently slow and labor intensive, resulting in lower efficiencies and higher costs. Figure 2 illustrates some of the problems associated with using conventional sifted or brushed on setter powders.

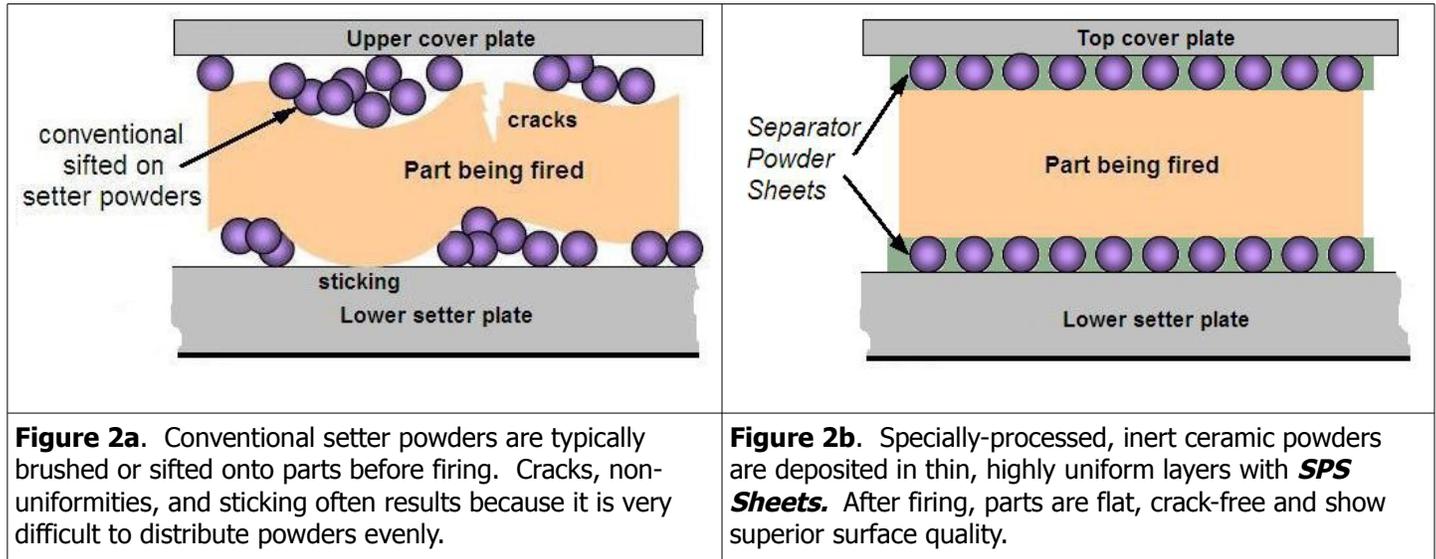


Figure 2a. Conventional setter powders are typically brushed or sifted onto parts before firing. Cracks, non-uniformities, and sticking often results because it is very difficult to distribute powders evenly.

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 show superior surface quality.

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 or sands and typical application methods. Figure 3 shows 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 several thin ceramic tapes stacked together with lighter-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 barrier that eliminates sticking while reducing surface friction that typically occurs when green parts shrink and densify at high temperatures.

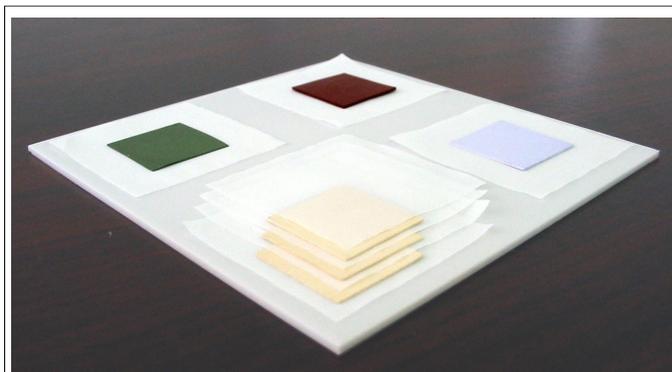


Figure 3a. Stack of thin ceramic tapes with light-grade **SPS Sheets** inserted between each tape prior to firing.



Figure 3b. Medium sized ceramic discs stacked with heavier-grade **SPS Sheets** inserted between each disc prior to firing

SPS Sheets have been shown to effectively prevent sticking and relieve stresses that lead to cracking problems, particularly with difficult to fire components such as thin ceramic plates and components which have glassy, volatile, or low melting phases such as PbO. Figure 4 (left) shows a tapecast PLZT ceramic plate that was fired using conventional sifted-on setter powders, and the dramatic improvement when an identical PLZT plate was fired using light-grade zirconia SPS Sheets (right).

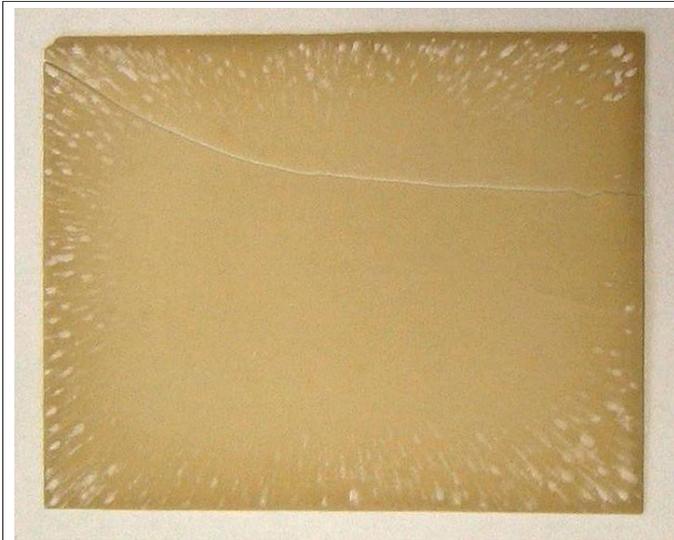


Figure 4a. A tapecast PLZT ceramic plate that was fired using conventional sifted-on setter powders shows the common problems of cracking and setter drag.



Figure 4b. An identical PLZT plate that was fired using fine 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 products including PZT/PLZT piezoceramics, capacitors, ferrites, superconductors, fuel cells, Low Temperature Co-fired Ceramics (LTCC), glass ceramics, powdered metallurgy products and other composite articles.

Table 1. Selection Guide for Separator Powder Sheet (SPS) Products.

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
SPS-AL-M-LS5	"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)
SPS-AL-M-A2UG	Medium grade aluminum oxide powder sheets. Typically used for firing small to medium size alumina plates, alumina-based components, and LTCC or HTCC laminates. Recommended for stack firing.	0.005 inch (127 μm)
SPS-MG-M	Medium magnesium oxide powder sheets. Typically used for firing SOFC fuel cells, LTCC, PZT/PLZT piezoceramics, and other small to medium size magnesia-based components. Recommended for stack firing.	0.003 inch (76 μm)
SPS-ZR-F	Fine 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)
SPS-ZR-M	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)
SPS-ZR-C	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)

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.

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.
- Produces thin ceramic plates that are crack-free and flat.
- Improves yields and quality.
- 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 Setter Powder 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.

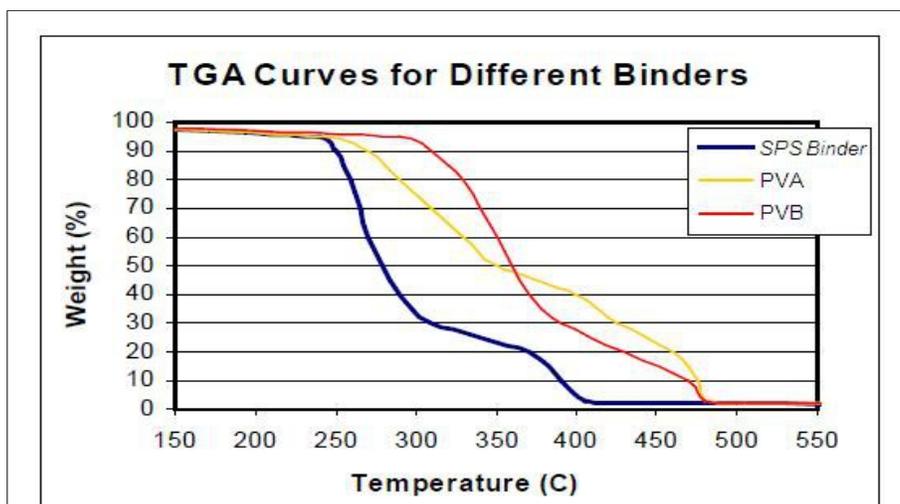


Figure 5. TGA curves for proprietary binder used in **Setter Powder Sheets** compared with binders commonly used for green ceramic forming and tapecasting such as PVA and PVB.