

Is Lo-Mass® Kiln Furniture Right for You?

Selecting Lo-Mass® Kiln Furniture for Pottery Kilns

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Lo-Mass® kiln furniture designs are produced from several types of advanced silicon carbide (SiC) refractory materials. Advanced SiC refractories are 10 to 28 times stronger than traditional SiC and cordierite refractory materials. The increased strength allows for substantially lighter kiln furniture components such as plates (shelves), support beams, and support posts. The important properties of advanced SiC materials are summarized in Table 1. The properties of traditional SiC and cordierite are also shown for reference.

Table 1. Properties of Kiln Furniture Materials

Typical Properties	Traditional Materials		Advanced Silicon Carbides		
	Cordierite	Silicon Carbide	ReSiC ¹	NSiC ²	SiSiC ³
Maximum Use Temperature (°F)	2336-2372	2822	2912	2642	2462
Density (lbs/ft ³)	119-131	162	160-175	175-180	185-195
Porosity (%)	20-30	15	15-18	<1*	<0.1
Modulus of Rupture >2192°F (psi)	1450-2900	8990	12,000-14,000	24,000-27,000	37,000-40,000
Modulus of Elasticity 77°F (kpsi)	2900-5800	23,200	30,000-35,000	32,000-34,000	48,000-54,000
Thermal Conductivity (BTU-in/hr-ft ² -°F)	7-10	97	145-180	85-125	165-270
Thermal Expansion (x 10 ⁻⁶ °F ⁻¹)	1.4-1.7	2.8	2.5-2.7	2.4-2.6	2.4-2.7

1 Crystar® recrystallized silicon carbide

2 Advancer® advanced nitride-bonded silicon carbide

3 Silit®SK reaction-sintered, silicon-infiltrated silicon carbide

*Double-fired NSiC

Lo-Mass® kiln furniture offers several advantages over traditional SiC and cordierite kiln furniture for pottery kiln applications. Higher strength allows for smaller cross-sections and lighter components. For example, a Lo-Mass® kiln shelf is thinner (5/16") than the typical 5/8" to one-inch thick traditional kiln shelf. Thinner cross-sections and excellent thermal properties result in faster heat transfer and greater energy efficiency. Firing cycles can often be completed in less time using less energy. Depending on the percentage of the total kiln load devoted to kiln furniture, thinner kiln shelves can significantly reduce the total load density and increase ware capacity.

Imagine all of your kiln shelves sitting in a large block in your kiln. Now imagine decreasing that block by 50% or even 75%! With this image in mind, it's not hard to imagine more ware in your kiln along with a lower energy cost per firing.

Advancer® Kiln Furniture

Advancer® Lo-Mass® kiln furniture has been steadily finding its way into gas-fired pottery kiln applications for the last several years. The Advancer® kiln shelf has been the product of choice over other advanced SiC materials because of its unique performance characteristics and lower cost. Certain application variables such as temperature, load, and ware compatibility may require the consideration and use of other advanced SiC materials. It is always best to consult an application specialist for Lo-Mass® material recommendations. Although Advancer® kiln furniture has a higher initial cost than traditional SiC or cordierite kiln furniture, a thorough economical analysis typically indicates a rapid return of the additional investment.

Lightweight is one of the most heralded attributes of an Advancer® kiln shelf. This results in less heavy lifting when stacking and un-stacking kiln loads. For example, a 24"x 12" Advancer® shelf weighs 8 lbs. compared to up to 21 lbs. for the same sized traditional SiC or cordierite shelf! If you have employees or students performing the kiln loading chores, the benefits are obvious.

As previously noted, a reduction in refractory mass results in a reduction of energy costs. Calculations based on a 24"x 12"x1" cordierite shelf compared to a 24"x 12"x 5/16" Advancer® shelf (fired at 2228°F with a cost of electricity at \$0.10/kWh) demonstrated that it costs \$0.30 (3 kWh) to fire the cordierite shelf and \$0.12 (1.2 kWh) to fire the Advancer® shelf. That is a savings of over 50%!

The Advancer® kiln shelf is made flat and stays flat. The manufactured maximum allowable deflection for a shelf is 0.003 inch/inch measured across the diagonal. A shelf will remain flat after many firings to cone 10 or 12 under heavy loading. At these temperatures, a 24"x 12" shelf will easily support a uniform load of 200 pounds (supported at three points) without warping after repeated firings. Lo-Mass® structural beams are also often used to support heavier traditional SiC and cordierite shelves to minimize warping.

With less than 1% porosity, it is very difficult for glaze drips to get a firm grip on the surface of an Advancer® shelf. With typical porosities for traditional SiC and cordierite ranging from 15% to 30%, it is almost a certainty that glaze drips will fuse onto and into the surfaces of these shelves requiring grinding for removal. Many users report that glaze and soda drips are easily scraped off an Advancer® shelf without grinding and without the use of any kiln wash. While the exclusion of kiln wash is not necessarily recommended for all users, the fact remains that the extremely low porosity of an Advancer® shelf make it difficult for most glazes to fuse onto the shelf surface.

Even with all of these excellent attributes, potters must still examine their specific kiln and firing application to determine if Advancer® Lo-Mass® kiln furniture is the right choice. As with any product, there are limitations.

Application Considerations

Users must understand that the Advancer® material is vastly different than traditional SiC and cordierite materials. While Advancer® kiln furniture is much stronger and can support far heavier loads, it is also more susceptible to mechanical damage or breakage if mishandled. Care must also be taken to prevent Advancer® kiln furniture from being exposed to prolonged moisture such as repeated condensation or rain because it has a tendency to dry very slowly. Even though the porosity of the Advancer® material is extremely low, prolonged exposure to moisture can still penetrate into the part. If an exposed part is fired under normal conditions, the low porosity does not allow moisture to readily escape and a steam explosion can occur. It is therefore recommended that Advancer® kiln furniture be stored in a dry, enclosed area that will not be exposed to inclement weather or ground moisture. If Advancer® kiln furniture is inadvertently subjected to moisture, it must be dried in accordance with a detailed drying schedule prior to normal use. Please consult an application specialist for more details. It should also be noted that the use of a kiln wash on Advancer® kiln furniture is very acceptable and does not constitute a moisture concern.

One of the most important concerns when using Advancer® kiln shelves is avoiding rapid or uneven heating and cooling that could possibly lead to thermal shock failure. Extreme temperature differences lead to unequal expansion within the shelf resulting in high internal (thermal) stresses. Sometimes these stresses are high enough in the shelf to trigger a crack. Think of it as pouring a liquid at room temperature on ice. The extreme temperature difference causes the ice to crack. Traditional SiC and cordierite shelves are typically coarse grain, pressed, porous compositions. As a result, a thermal shock crack may start at one edge and stop a short distance into the shelf by finding a spot to "dead-end". An Advancer® shelf is a fine grain, slip cast composition with a much higher density. As a result, a thermal shock crack will almost always propagate through the shelf causing ultimate failure.

With thermal shock in mind, the use of Advancer® shelves is not recommended where direct flame impingement will occur. Raku firing and some wood firing applications where direct flame impingement are almost a certainty are not good choices for Advancer® shelves. Similarly, Advancer® shelves should not be used whenever rapid and potentially uneven temperature changes are anticipated. Forced cooled firing profiles are not recommended unless they are absolutely controlled for temperature uniformity. Some Advancer® shelf failures have been observed on the bottom layer of kiln car settings. This is most likely caused by cold air being drawn through leaky car seals when the kiln is shut off or by excess heat retention of the car bed when compared to the rest of the kiln. It is typically recommended that the bottom shelf layer be comprised of thicker traditional SiC.

It is also recommended not to use excessively massive support posts with Advancer® shelves. Commercially extruded posts with a hole through the center are acceptable as are dense brick soaps and Lo-Mass® beams and beam sections used vertically or horizontally. Full size dense brick used as posts may retain enough heat at the support area to cause temperature differences during cooling that can lead to thermal shock failure. Such cracks usually follow a crescent shaped path around the offending post (brick). Clay wadding can also be used to help reduce the likelihood of these problems.

Kiln Applications

Soda

Advancer® kiln shelves may be used successfully in soda firing when soda is introduced indirectly into fireboxes using wet or dry methods. Due to the extremely low porosity of an Advancer® shelf, soda drips are usually easy to remove by hand scraping after each firing. Advancer® shelves are not recommended for applications where water/soda combinations are sprayed directly onto the shelf. An Advancer® shelf is susceptible to thermal shock failure under these conditions. A thicker traditional SiC shelf is better suited for direct spraying applications.

Wood-Fired

While Advancer® kiln shelves have been used successfully in wood-fired kilns, consideration must be given to the placement of shelves so they are not subjected to direct flame impingement or uneven temperatures. In wood-fired kilns with multiple chambers, Advancer® shelves have been used successfully in second and third chambers where temperature rises are gradual and direct flame impingement is not an issue. If these chambers are stoked with wood at later stages of the firing, it is important that temperatures are already high enough to allow for a gradual increase and/or the shelves are stacked or shielded in a way that prevents direct flame impingement. A combination of Advancer® shelves and traditional SiC shelves is often a good option in areas where temperature uniformity is a problem.

It is also worth noting that an Advancer® shelf is likely to exhibit more profuse glass dripping from the alkalis present in wood-fired atmospheres. A traditional SiC shelf will exhibit a certain amount of glass dripping in wood-fired atmospheres due to oxidation; however, the problem is compounded with an Advancer® shelf because of its higher surface area of silicon carbide (i.e., fine grain sizing, low porosity). An Advancer® shelf also has a protective oxide (glass) layer. The glass layer is intentionally formed during manufacturing to further protect the Advancer® shelf from the destructive effects of oxidation. When excess alkalis are present, which is the case when wood is a fuel source, the alkalis will flux the glass layer and lower its viscosity causing the glass to drip or foam more readily. The effect is less pronounced in second or third chambers where direct wood stoking is minimal.

Electric Kilns

Advancer® kiln shelves are increasingly being used for high fire applications in electric kilns. The Advancer® material is electrically compatible with resistance coil element kilns. The lightweight and lower mass attributes of an Advancer® shelf offers several advantages over a traditional shelf. A one-inch thick cordierite shelf has been the standard choice for electric kiln firings to cone 6 and above. A one-inch thick cordierite shelf also consumes a lot of energy and a lot of stacking space. This is especially the case with 7 to 20 cubic foot top-loading kilns where space is at a premium. Not only will an Advancer® shelf stay flat; its 5/16" thickness allows for more stacking space and reduced energy costs. It is also easier to lift in and out of top-loading kilns. Compare the weight of a 26" diameter, 12-sided Advancer half shelf at 8 lbs. to the same size one-inch thick cordierite shelf at 23 pounds! The initial investment for Advancer® shelves is significantly higher than cordierite shelves in this application; however, it is easy to realize a substantial return on investment.

Porcelain

The Advancer® kiln shelf is the choice of many potters specifically because of its ability to resist glaze from fusing onto the shelf surface; however, most porcelain clay bodies will stick to an Advancer® shelf. Unglazed porcelain foot rings and pot bottoms will fuse onto a shelf surface so tenaciously that pots cannot be removed without breaking off the fused portion. Similar to a wood-burning kiln, the alkalis in the porcelain glaze will migrate under the ware and flux the glass layer of the shelf (especially at higher temperatures). This lowers the viscosity of the glass layer making it very sticky. These potentially destructive effects can be overcome by using an appropriate high alumina kiln wash. Due to its extremely low porosity, kiln washing an Advancer® shelf is like trying to re-glaze a fired pot that has already been glazed. Application of kiln washes is facilitated by pre warming shelves to promote drying. Several thin coats of an appropriate low clay content wash will have less of a tendency to lift off during drying and firing. The manufacturer also provides a fired

coating designed for porcelain compatibility and the ultimate adherence to an Advancer® shelf. It is best to consult an application specialist for a specific kiln wash or coating recommendation.

Tile

The Advancer® kiln shelf is a logical choice for tile production firings. It is obviously difficult to yield flat tile without a flat firing surface. An Advancer® shelf provides such a surface and remains flat after repeated firings to cone 10 and beyond. Due to the manufactured flatness uniformity of Advancer® shelves, tiles can often span the seam of two shelves (butted together) without noticeable deformation (provided all posting is even and level). Care must also be taken in the placement of tile on Advancer® shelves to avoid temperature differences that could possibly lead to thermal shock failure. This is especially the case with tile having a thickness of 3/8" or more. For example, if thick tiles are placed to cover an entire shelf except around the edge, the exposed edge can act as a cooling fin while heat is retained under the tile. The temperature difference could possibly lead to thermal shock failure. Similar to an electric kiln application, energy savings and increased stacking space are obvious advantages for tile production firings.

Lo-Mass® kiln furniture offers many advantages over traditional kiln furniture. The substantial strength of Lo-Mass® kiln furniture allows users to significantly reduce their refractory to ware ratio resulting in increased productivity. The strength and thinner cross-sections (i.e., less refractory mass) along with excellent thermal properties also result in faster heat transfer and substantial energy savings. Any increase in energy costs makes the return on investment even more attractive. Other advantages include lightweight, flatness retention, less maintenance, and longer life. It is not hard to understand why many potters are now using Lo-Mass® kiln furniture. Given a proper application evaluation, you might discover that Lo-Mass® kiln furniture is the right choice for you!

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