IMPROVE YOUR BOTTOM LINE

WAM®

AL II

WESTADMAT.COM

Your Partner for Corundum Free Refractories

Westmoreland® Advanced Materials

WAM® AL II TECHNOLOGY

Reduce Costs.

Minimize Maintenance.

Improve Quality.

The WAM® AL II technology consists of a family of products that address the diverse refractory needs of the aluminum industry. Each product incorporates properties that allow it to address specific application issues associated with a variety of metal contact processes.

All products within this family are comprised of high purity synthetic materials with only trace amounts of Silicon Dioxide (SiO_2) and other oxidizing agents, which contribute to undesirable corundum formation. In addition to its chemical inertness, each WAM® AL II product is immune to molten aluminum penetration as a result of its unique chemical formulation.

This base technology is the building block for the family of products that allows for complete furnace lining design which can reduce energy consumption, minimize required maintenance, improve metal quality, reduce landfill disposal costs, and lessen the total cost of ownership for your refractory linings.

Beat the Corundum Conundrum

Corundum forms as a result of the oxidation of aluminum metal. Whenever oxygen comes in contact with the metal, the oxide forms. This is a result of the unique characteristic of the metal. When excessive corundum forms, it reduces energy efficiency, furnace throughput, increases maintenance, and causes metal loss. Corundum growth can be minimized by limiting available oxygen sources, including components of refractory linings. This, in combination with managing heat sources, maintenance, and metal quality, can drastically reduce your costs to produce.

Traditional refractory linings developed for the aluminum market contain 20%-30% silicon dioxide. WAM® AL II and WAM® AL II Gun Mix contain less than 0.3%, and WAM® AL II HD contains less than 0.8%. This, and the stable chemical nature of the product eliminate the possibility of corundum formation as a result of metal interaction with the lining. Because metal will not penetrate, you will never see corundum formation bonded to or formed within the lining.

Furnace linings can be zoned with micro-porous WAM® AL II, WAM® AL II Gun Mix and higher strength WAM® AL II HD optimizing energy efficiency, resistance to corundum formation, and mechanical strength in the areas that need it. Operators can improve operational efficiency, reduce maintenance costs, and shorten cleaning outages. The WAM® AL II family of products has been developed with installers in mind, so no special installation methods are required and it's extremely easy to install.

Improve Your Bottom Line

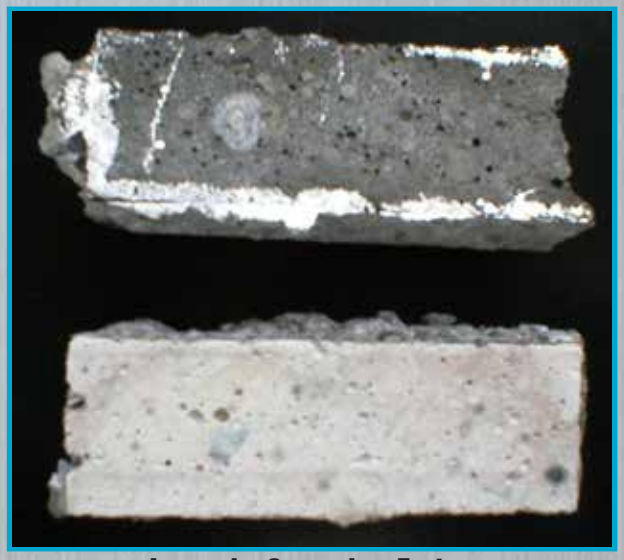
Lower Your Total Cost of Ownership

The cost of a refractory lining is the sum of the cost to purchase the refractory, install the refractory, and maintain the refractory. It is a function of the refractory lifetime and the Thermal Efficiency Lifetime (TEL) of the vessel, the latter relating to the insulating capability over the lifetime of the lining. Compared to standard refractories, a WAM® AL II technology based furnace will have a higher cost per pound of refractory, a lower amount of refractory required (low-density compared to standard refractories), an average 2-3 time longer lifetime, a much longer TEL, and 50% or less maintenance costs and downtime. This results in a total cost of ownership significantly less than standard refractories. In fact, customers have measured purchase price pay-backs of 12 months or less.

The unique chemical and mineralogical makeup of every product in the WAM® AL II Family eliminates internally formed corundum, so your lining will not lose energy efficiency over the course of its service life. This results in a very long TEL, and is a major contributor to lower cost of ownership along with reduced maintenance costs.

True Green Recyclable Refractory

WAM® AL II linings provide value to your operations for the entire lifetime of the refractory lining, and then some. WAM® AL II products have significantly improved lifetimes due to their inertness. Because the refractory is silica free, there are no concerns of potential silicosis issues now, or in the future.



Immersion Comparison Test

It is also because of this inertness that WAM® AL II products are completely recyclable.

Since they do not react with the process metal, we can take your WAM® AL II lining back at the end of its service life reducing your waste stream and eliminating your landfill costs. Add up all these costs and you will see that a WAM® AL II lining is the least expensive option over the lifetime of your process vessel - even at the end of its life in your vessel.

It truly is the only CLEAN and GREEN refractory option.

THE WAM® AL II FAMILY

AL II - Castable

A medium density, micro-porous, low thermal conductivity castable for metal contact use in holding furnaces, melting furnaces, launders, transport vessels and ancillary metal handling applications.

AL II HD - High Density

Dense, low water castable to address the need for high strength in impact areas, ramps, sills, and reverb sidewalls.

AL II G - Gun Mix

Micro-porous gun mix for dry gunite application of new linings or repair of existing metal contact linings.

AL II LW - Lightweight

A lightweight refractory castable designed to provide significant insulating capability at a reduced weight. Ideally suited for transport vessels, as well as roofs and upper sidewalls of large head space furnaces.

AL II HD Brick

Dense, strong brick shapes for use in reverbs, round top charged melters and other applications where brick linings provide the needed service characteristics.

WAM® AL II - Castable

A Hotface Material That's Insulating

Compared to standard dense refractories commonly used for metal contact areas in aluminum melters and holders, WAM® AL II is far more insulating and far less prone to problems with corundum formation. Unlike other insulating materials reportedly suitable for metal contact applications, such as boards, WAM® AL II is never penetrated by the metal, nor converted to corundum. Therefore, it maintains its thermal efficiency throughout its lifetime. For a copy of the research report that describes in significant detail the reasons why this is true, ask your WAM® representative.

Insulate Better and Save More

Insulation capability of refractory materials is frequently compared using the 'Coefficient of Thermal Conductivity', or the 'K Factor'. This property is also used to calculate shell temperatures of refractory lined vessels and expected heat loss. The K Factor for low cement and acid bonded dense monoliths in the range of 70% alumina, is around 15 Btu in/h ft² °F (2.16 W/m K). WAM® AL II is a micro-porous metal contact refractory with a K Factor of 4.8 Btu in/h ft² °F (0.69 W/m K) at 1470°F (800 °C); this is roughly three times the insulating capability of standard dense, metal contact refractories.

Add Up Energy Savings

An electrically heated holding furnace lined with an acid bonded 65% alumina working lining uses 3450 kWh per week to maintain a set point temperature of 1250 F (676.7 °C) for a 300 series alloy. An identically configured holder with a WAM® AL II working lining uses only 2840 kWh per week to maintain the same set point temperature. Each week the consumption of electricity is reduced by 610 kWh, at a cost of $0.055 per kWh, for a weekly savings of $33.55 per furnace and an annual savings of $1744.60 per year per furnace. Corundum grows and penetrates the acid bonded lining in time. This increases the conductivity of the overall lining, thus increasing the differential energy usage with time. The cost to operate this furnace increases with time as well. The greater the furnace surface area, the greater the Loss or Savings, depending on which lining you choose.

WAM® AL II HD - High Density

The Case for Refractory Strength

The WAM® AL II Technology is based on a chemically inert unique mineralogy that eliminates metal penetration and corundum formation as a result of metal refractory interactions. WAM® AL II HD combines this unique refractory aggregate with low water and low cement binder technology, creating a refractory with all the benefits of the WAM® AL II technology and high strength characteristics necessary to handle impacts, abrasion, and erosion resulting from various processing conditions.

The fact is that the strength of the corundum generated, which penetrates and builds up on typical refractories, is significantly stronger than any available refractory. No lining will remain intact during removal of any corundum buildup that has penetrated or formed within the lining. The logical alternative is to select a lining material that that does not allow penetration or buildup, and does not chemically bind with formed corundum. The paradigm shift with WAM® AL II technology is that a strong refractory is not necessary, only an inert one. A study published by Die Cast Engineer magazine in November, 2008, measured the average MOR of corundum buildup at over 15,000 psi (103 MPa) and an average CCS of over 30,000 psi (207 MPa).

Higher Density.
Higher Strength.

If we disregard strength required to survive the cleaning process, high strength refractories are still necessary to resist erosion, abrasion and mechanical stresses inherent to metal handling processes. Examples are abrasion due to scrap and ingot loading, erosion of furnace tapout streams, and erosion and impact from ladle turn-downs. Application areas include lentils, jams, ramps, sills, impact pads, and tapout blocks.

Compared to many refractory monoliths used for metal contact areas of aluminum melters, holders, transport ladles and troughs, WAM® AL II HD is stronger, more erosion resistant, and immune to the problems of corundum formation. The high density property of this material makes it ideal for high fluxing environments such as scrap furnaces and siphon ladles.

WAM® AL II G - Gun Mix

Faster Installation

In our continuing effort to provide new technology that is easier to use, we created a way to install our silica-free, micro-porous refractory with conventional dry gunning equipment:

WAM® AL II G is the gunning version of our unique refractory, WAM® AL II. This mix is designed to gun with incredibly low rebounds, provide a lamination free lining, and allow plenty of time to trim to the right lining thickness. Installers can now eliminate the need for forming, place materials at a higher installation rate, and put the manufacturing process back on line faster. Now there are two ways to install a WAM® AL II working lining for aluminum furnaces that will reduce energy consumption and provide a significant reduction in maintenance efforts as expected from the WAM® AL II technology family.

What Rebounds?

Installers using gun mixes are satisfied when getting 10%-15% rebounds, after all this is fairly typical. WAM® AL II G has typical rebounds of 5% or less, keeping more product on the wall and less in the trash. This reduces your overall cost and increases the speed of installation. Typical of Westmoreland Advanced Materials®, we are not satisfied with meeting industry standards, only in exceeding them.

WAM® AL II LW - Lightweight

NEW to the WAM® AL II Family

WAM® AL II LW is a lightweight refractory castable designed to provide significant insulating capability at a reduced weight, all while remaining inert to reactions with molten aluminum metal. Transport vessels are ideal application areas, where one desires to limit the overall weight of the vessel while maximizing the weight of transported metal. WAM® AL II LW allows this while maintaining its efficient thermal profile since the lining is not degraded by penetration of metal and subsequent formation of corundum.

It is also ideally suited for roofs and upper sidewalls of large head space furnaces. These are the areas were a majority of heat loss occurs. WAM® AL II LW is able to provide a highly insulating lining while maintaining inertness with molten metal splash, which affords many tremendous operational advantages to the user.

Line Your Furnace With Efficiency

The weight of refractory required to line a roof with WAM® AL II LW is significantly less than standard dense castables commonly used. This allows OEM's the opportunity to reduce the steel supporting structure and thereby lower the overall cost of the construction of a vessel. Along with WAM® AL II, WAM® AL II LW offers another material for use as floats or other refractory devices that must have a density lower than molten aluminum. Because of the lower density, no refractory inclusions will occur since any loose material simply floats to the top of the bath and is easily removed.

WAM® AL II LW completes the family of inert refractory products specifically designed for molten aluminum contact applications. This allows for the design of a vessel's refractory lining to provide toughness where needed and thermal efficiency where desired, along with the standard inertness of the WAM® AL II family.

WAM® AL II - Technical Data

		WAM® AL II Castable	WAM® AL II HD High Density	WAM® AL II G Gun Mix	WAM® AL II LW Lightweight
General Technical Data	Classification	Special Cement Castable		Gun Mix	Sp.Cm. Castable
	Placement Method	Vibration Casting		Dry Gunning	Vibration Casting
	Available Application Packs	These products are designed specifically for aluminum contact applications			
	Typical Water Req. % (wt.)	22%	8%	0-5%	30%
	Material Required For Estimating	115 (lb/ft^3)	168 (lb/ft^3)	121 (lb/ft^3)	66 (lb/ft^3)
		1842 (kg/m^3)	2691 (kg/m^3)	1938 (kg/m^3)	1057 (kg/m^3)
	Max. Recommended Service Temperature	2600 (°F)	3100 (°F)	2600 (°F)	2800 (°F)
		1427 (°C)	1700 (°C)	1427 (°C)	1538 (°C)
Chemical Analysis: Calculated wt.% Based on Common Oxides	Aluminum Oxide (Al_2O_3)	64.9%	78.6%	64.9%	77%
	Silicon Dioxide (SiO_2)	0.3%	0.7%	0.3%	0.3%
	Titanium Dioxide (TiO_2)	0.1%	<0.1%	0.1%	0.1%
	Iron(III) Oxide (Fe_2O_3)	0.1%	0.1%	0.1%	0.1%
	Calcium Oxide (CaO)	24.3%	10.5%	24.3%	11.9%
	Magnesium Oxide (MgO)	0.2%	<0.1%	0.2%	0.2%
	Combined Alkali Oxides ($Na_2O + K_2O$)	0.2%	0.1%	0.2%	0.3%
	Other	10%	10%	10%	10%
Thermal Conductivity	($BTU\text{-}in/ft^2\text{-}hr\text{-}°F$) 750 (°F)	5.3	11.8	5.3	2.6
	(BTU-in/ft2-hr-°F) 1470 (°F)	4.8	10.8	4.8	2.3
	(BTU-in/ft2-hr-°F) 2200 (°F)	5.3	10.1	5.3	2
	(W/m K) 400 (°C)	0.76	1.70	0.76	0.38
	(W/m K) 800 (°C)	0.69	1.56	0.69	0.33
	(W/m K) 1200 (°C)	0.76	1.46	0.76	0.28
Density	After 230 (°F)	130 (lb/ft^3)	174 (lb/ft^3)	138 (lb/ft^3)	72 (lb/ft^3)
	After 1500 (°F)	115 (lb/ft^3)	168 (lb/ft^3)	121 (lb/ft^3)	66 (lb/ft^3)
	After 110 (°C)	2082 (kg/m^3)	2787 (kg/m^3)	2211 (kg/m^3)	1153 (kg/m^3)
	After 815 (°C)	1842 (kg/m^3)	2691 (kg/m^3)	1938 (kg/m^3)	1057 (kg/m^3)
Modulus of Rupture	After 230 (°F)	1520 (psi)	3950 (psi)	1320 (psi)	200 (psi)
	After 1500 (°F)	740 (psi)	3470 (psi)	560 (psi)	110 (psi)
	After 2500 (°F)	680 (psi)	3520 (psi)	n/a	n/a
	After 110 (°C)	10.5 (MPa)	27.2 (MPa)	9.1 (MPa)	1.38 (MPa)
	After 815 (°C)	5.1 (MPa)	23.9 (MPa)	3.9 (MPa)	0.76 (MPa)
	After 1370 (°C)	4.7 (MPa)	24.3 (MPa)	n/a	n/a
Cold Crushing Strength	After 230 (°F)	9530 (psi)	11,340 (psi)	8990 (psi)	960 (psi)
	After 1500 (°F)	4790 (psi)	11,070 (psi)	3870 (psi)	510 (psi)
	After 2500 (°F)	4610 (psi)	11,450 (psi)	n/a	n/a
	After 110 (°C)	65.7 (MPa)	78.2 (MPa)	62 (MPa)	6.62 (MPa)
	After 815 (°C)	33 (MPa)	76.3 (MPa)	26.7 (MPa)	3.52 (MPa)
	After 1370 (°C)	31.8 (MPa)	78.9 (MPa)	n/a	n/a
Permanent Linear change (%)	After 230 (°F) or 110 (°C)	n/a	n/a	n/a	n/a
	After 1500 (°F) or 815 (°C)	-0.1%	-0.1%	-0.1%	-0.1%
	After 2500 (°F) or 1370 (°C)	-0.3%	-0.2%	n/a	n/a

WAM® - Who We Are

Welcome to Westmoreland Advanced Materials

Westmoreland Advanced Materials®

WESTADMAT.COM

Westmoreland Advanced Materials® manufactures High Quality Castables, Shotcretes, Gun Mixes, and Low Cement & Ultra-Low Cement Compositions using the latest Technology and Raw Materials. We also Custom Toll Blend & Package Dry Mortars. Westmoreland Advanced Materials® is a problem solving organization that prides itself in setting high standards, and delivering today's and tomorrow's innovative solutions to the materials industry. Our Plant is Located Southeast of Pittsburgh, Pennsylvania, on the Monongahela River providing Quick Access to Major Highways and to Rail & Barge Terminals.

Dr. Ken McGowan

Ken McGowan is a chemist by training. He received both M.S. and Ph.D. degrees during the initial downturn in heavy industry in the U.S. Ken realized that industry needed new and advanced materials technologies in order to remain competitive and grow. As a result, he spent a significant amount of his career developing unique and innovative technology solutions for a variety of specific applications. He has consulted for many of today's largest industrial firms. Dr. McGowan founded WAM® in an effort to provide cost effective, problem-solving, and long-term materials solutions to promote industry advancement. This is in contrast to the traditional refractory industry approach of providing short-sighted, short-termed, commodity solutions.

Bob Cullen

Bob Cullen manages the Technology Group for Westmoreland Advanced Materials®. Bob, a founder of WAM®, holds a B.S. in Ceramic Engineering and an M.S. in Material Science. Over his career, Bob has consulted for both refractory manufacturers and users around the country. Bob has significant knowledge in both shaped and unshaped refractory systems. He has developed castable systems, forms of which are utilized by every major refractory supplier today. As a co-founder of WAM® Bob provides technological advances, which encompass formulation and placement, as well as raw material synthesis and development.

Services by WAM®

Engineered Precast Shapes

We provide temperature and humidity controlled casting as well as high temperature firing. Large or small, WAM® will manufacture your shapes of varying complexity, density, and strength via the most effective casting and curing techniques.

Toll Manufacturing

Consider letting us provide our quality products in your bag. If you have predetermined mix formulations, we can manufacture these as well.

Consulting

Whether you have a problem to solve or a new process to develop, we'd be happy to apply our years of expertise in high temperature technology and processes to help you achieve your goals.

Other Value Added Refractories Available From WAM®:

Conventional Cement Castables (SC)

Low Cement Castables (LC)

- -Alumina Based
- -Spinel Based
- -Silica Based
- -Silicon Carbide Based

Ultra Low Cement Castables (ULC)

No Cement Castables (NC)

- -Alumina Based
- -Silica Based Construction

Construction Grade Castables (CG)

Lightweight Castables (LW)

- -Standard Lightweight Castables
- -Low Conductivity Series

Enhanced Matrix Technology (EMT)

Gunning Mix Technology (G, RG)

- -Standard Cement Gun Mix
- -Reduced Cement Gun Mix

Construction Grade Gunning Mix Technology (CG G, CG RG)

- -Standard Cement
- -Reduced Cement

Dry Mortars (M)

- -Air Set
- -Heat Set

Wire Fiber Slurry Technology (WFS)

- -Alumina/Mullite Based
- -Alumina Based

BLG Technology Systems

- -BLG
- -Mortar

WESTMORELAND ADVANCED MATERIALS

www.westadmat.com
110 Riverview Drive
Monessen, PA 15062
Phone: 724-684-5902
Fax: 724-684-5962
sales@westadmat.com

IMPROVE YOUR BOTTOM LINE

		WAM® AL II Castable	WAM® AL II HD High Density	WAM® AL II G Gun Mix	WAM® AL II Lightweight	WAM® AL II Brick
Features/Benefits	Micro Pourous	✓		✓	✓	
	Silica Content <0.9%	✓	✓	✓	✓	✓
	Low Water		✓			
	Pre Cast Shapes	✓	✓		✓	
	Metal Contact	✓	✓	✓	✓	✓
	Reduces Corundum	✓	✓	✓	✓	✓
	Reduces Maintenace	✓	✓	✓	✓	✓
	High Density		✓			✓
	Stable Mineralogy	✓	✓	✓	✓	✓
	Conventional Installation	✓	✓	✓	✓	✓
Applications	Die Cast Holding Furnaces	✓	✓	✓		
	Rotary Degassing Units		✓			✓
	Reverb Ramps/Sills/Jambs		✓			✓
	Reverb Lower Sidewalls	✓	✓	✓		✓
	Reverb Upper Sidewalls	✓	✓	✓	✓	✓
	Reverb Hearths	✓	✓	✓		✓
	Launders	✓	✓			
	Ladles	✓	✓	✓	✓	
	Dosing Furnaces	✓	✓	✓		
	Stack Melters		✓	✓		✓
	Banjos	✓	✓	✓		
	Taphole Boxes		✓			
	Furnace Roofs				✓	
	Furnace Doors	✓	✓	✓	✓	
	Rotary Furnaces		✓			✓
	Back Up Lining				✓	
	Transport Vessels	✓			✓	