REFRACTORY CASTABLES: THE TOP 20 MAIN FAILURES WITH REFRACTORY CASTABLES. Products, Diagnosis and Solutions.

April, 2026

Introduction:

A recurring issue for users of refractory materials is the **various problems or failures that are commonly observed in the handling, installation, drying, and operation** of the different refractory materials used in various thermal equipment (boilers, furnaces, combustion chambers, etc.). These issues often lead to questions for us, the suppliers, in the best-case scenario, since many times the problems go unnoticed and operation continues until the materials collapse, resulting in lost productivity and money.

In this bulletin, we want to summarize some of these problems that arise, **particularly with refractory concretes.** There are certainly many more in reality, but we will at least list the 20 main or most frequent ones.

Here is a list of the 20 main problems or difficulties in the use of refractory concretes, their probable causes, and possible solutions:

1) Lack of setting, or delay in the setting process of refractory concretes:

Observation: The concrete is not setting, or the setting time is delayed, exceeding the manufacturer's specified values. This prevents the removal of formwork, molds, and cores.
The influential factor in these cases is the cement content. This has a specific validity period and percentage in the mix. Outside of this validity period, it is recommended to perform a setting test and measure the setting times.

Probable Causes:

- Concrete expiration date since manufacturing.
- Excess water in the mix (above the specifications in the technical data sheet).
- Water accidentally entering the mix during pouring.
- Inadequate water quality.
- Very low temperature. These problems appear below 10°C, and become more severe below 0°C.
- Dirty equipment, such as the mixer, shovels, vibrators, etc.

Some corrective measures:

Use material within its expiration date.

- ✓ Remove the installed material with the problem and reinstall it with the new product.
- ✓ Use potable water in the same or slightly different percentage than that indicated by the manufacturer. Do not use excess water. Add water gradually.

- ✓ Work at an ambient temperature above 10°C. If it is lower, adjust the work area. Hot water can be used, and pallets of material can also be warmed by placing them near ovens or other warm areas of the industrial plant.
- ✓ Use thoroughly clean mixers and implements.

2) Excessively high temperature on the outer sheet of the thermal equipment:

Observation: In certain areas of the furnace shell or casing, or throughout the entire structure, temperatures significantly higher than those predicted when the two lining layers—the insulating and refractory layers—were defined.

Probable Causes:

- Error in calculating the thicknesses and grades of the insulating (lightweight) and refractory (dense) materials.
- Incorrect installation, not adhering to the thicknesses or grades resulting from the thermal calculations.
- Use of the wrong mixer, water percentage, and installation procedure, whether for insulating or refractory concrete.
- Defective formwork or formwork that allows significant material loss.

Some corrective measures:

- ✓ Review boundary conditions: actual temperature of the hot face, temperature distribution, ambient temperature, wind speed, etc.
- ✓ Recalculate the thermal parameters using the corrected data and the thermal conductivities of each product.
- ✓ Adhere to the thicknesses resulting from the calculations.
- ✓ Use a mixer suitable for each product. Insulators typically use horizontal-axis mixers, while refractories use vertical-axis mixers.
- ✓ When dealing with concentrations of material in a particular area of the sheet metal, a temporary solution is to perforate the sheet and inject insulating products (ceramic fiber-based) to address the problem from the outside.

3) Pronounced wear at the joints of the panels or cast sections:

Observation: When a castable installation is done in panels, or rectangles that share a joint between them (as indicated by a correct installation); after a time of use it is observed that these joints become excessively widened promoting the general wear of the entire panel and forcing the equipment to be taken out of service for repair.

Probable Causes:

- Excessive linear variation of the selected product, which promotes high thermal expansion. This, combined with the stresses inherent in the oven as a whole, begins to wear down the edges of the joints, widening them over time.
- Incorrect installation of the product, causing defects in the joints upon removal of the formwork.

Some corrective measures:

- ✓ Review the product selection, choosing the one that causes the least possible linear variation in this application.
- ✓ Review the entire product installation and convective drying process.
- ✓ Ensure that the formwork is well-made to guarantee regular joints, without deformation or misalignment.
- ✓ Consider the possibility of installing a compensating joint where appropriate (ceramic fiber).

4) Explosion inside refractory concrete:

Observation: A common problem, especially with thicker coatings made of dense or low-porosity materials (low cement, ultra-low cement, etc.), is the problem of partial or total blasting of the coating. Remember that the water contained in the coating, during heating (controlled or not), must travel through the entire applied thickness as steam and be expelled. If it cannot escape, either due to low porosity or because the heating rate is too high and generates much higher pressure steam, this pressure will cause the installed thickness to explode and destroy it.

Probable Causes:

- The materials are too dense and lack additives or binders that aid or accelerate the drying process (fiber-reinforced concrete, rapid-drying concrete).
- No method has been provided to channel water vapor through the installed thickness. Keep in mind that the insulating concrete (the outermost layer) has a water content that can be 3 to 10 times higher than that of the refractory material installed further down. A significant amount of water needs to be removed from the bottom.
- The drying method may have been too premature (not respecting at least 24-48 hours after concreting). There may be a significant amount of unset, or semi-liquid, material.
- The drying methods used may not accurately follow the drying curve recommended by the manufacturer. Excessive rapid heating will almost certainly cause an explosion. Special attention must be paid to the temperature range from 100°C to 220°C, as this is when water vapor is most concentrated.
- The amount of water added during the concrete mix must comply with the manufacturer's instructions. Less water will result in greater density (more resistance to steam). More water will generate more steam. Both situations are detrimental. Remember that the steam will continue to increase pressure until it overcomes the resistance of the coating. The greater this resistance, the greater the potential for an explosion.

Some corrective measures:

- ✓ Use materials specifically designed for better or faster drying.
- ✓ Install steam outlet channels using thin plastic cords or other alternatives.
- ✓ Perform convective drying using external equipment capable of producing the appropriate drying curve for the coating. Drying through the gradual start-up of the equipment's burners or other improvised drying methods using wood or other combustible materials does not allow for the accurate and reliable production of a drying curve. These methods are not designed for such applications.

5) Mechanical resistance too low:

Observation: In this problem, the user perceives low resistance. The product comes off or breaks easily. Sometimes it crumbles into powder simply by running a hand over the surface. Or, by inserting a wire, it becomes clear how easily it does so.

Probable Causes:

• Adding too much water to the concrete during mixing, or an accidental or intentional addition to the formwork.

• Formwork made of materials that absorb a lot of water from the mix.

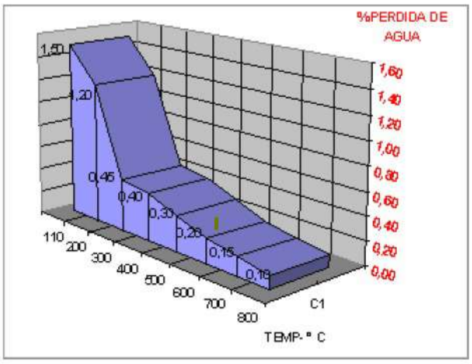
• Extreme outside temperatures. Very low temperatures can cause freezing, which prevents the water from reacting with the cement. Very warm temperatures increase water evaporation, reducing its percentage in the mix and negatively accelerating setting.

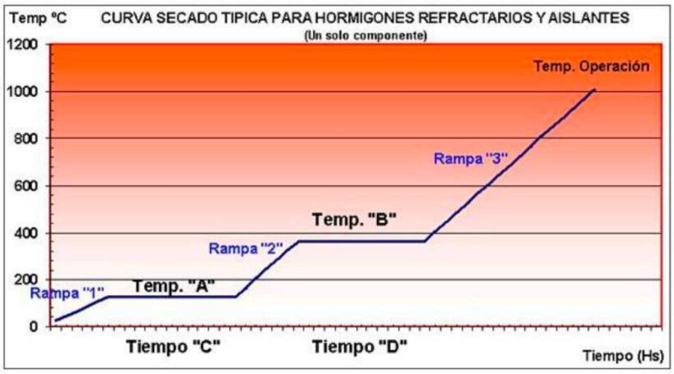
• Inadequate mixing conditions (incorrect machine, water, vibration, and timing).

• The effect of **"alkaline hydrolysis."** This occurs when the water contained in the concrete reacts (under certain conditions such as heat, humidity, oxygen, and setting time) to form carbonates. This carbonate formation removes some of the water, preventing it from bonding with the refractory cement and thus significantly reducing its strength.

Some corrective measures:

- ✓ Careful installation: Use a suitable mixing machine and adhere to the proper mixing procedures. Use the percentage of water indicated in the technical data sheet, within the tolerances allowed by the manufacturer, if any.
- ✓ Construct formwork, molds, and cores that are waterproof or absorb a minimal amount of water.
- ✓ Ensure the environment where the concrete is mixed maintains temperatures between 10°C and 25°C. In the first case, work indoors, if possible near the kilns. In the second, protect the mix from the heat or add chilled water.
- ✓ To prevent **alkaline hydrolysis**, use high-quality materials (low alkali content), and after a suitable curing time, **perform convective drying** to ensure the complete removal of water (both liquid and chemically reacted). This effect is predominant in insulating concretes.
- ✓ Keep the outer face of the coating moist with water spray or damp blankets, so that the setting process (especially in insulation) takes place without the temperature "drying" the outer part.





6) Cracks after setting in joints:

Observation: Cracks or fissures are observed near the joints between concrete panels, deteriorating the joint. These joints also tend to shift or lift.

Probable Causes:

- Inadequate formwork construction, both in design and fabrication.
- Inappropriate formwork fitting, causing stress during dismantling or removal. This can lead to minimal movement of the concrete, resulting in cracks appearing at the affected area.
- Impact after casting.

Some corrective measures:

- ✓ Proper formwork construction, both in design and fabrication.
- ✓ Proper formwork fit to the equipment, facilitating easy, quick, and safe removal.
- ✓ Protect the pouring area with warning tape or barriers to prevent access.

7) Cracks at joint corners:

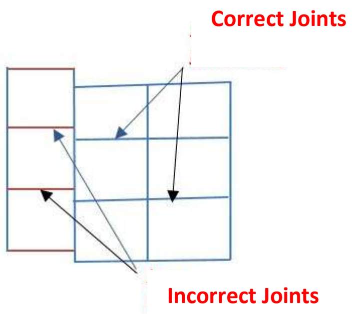
Observation: Minimal cracks (less than 1 mm) are evident, which divide some panels almost always in the vicinity of the joints between them.

Probable Causes:

- Design and construction of the joints. The joints are misaligned, causing cracks..

Some corrective measures:

- ✓ Preparation and design of the formwork to align joints between panels to be filled.



8) Violent destruction, destroyed cladding, missing sections, cut anchors:

Observation: Sometimes, a particular section of a wall covering can literally "disappear" after a period of use. When we examine the area, we find entire panels torn off, anchors severed, and joints missing. It's as if an extraordinary force has ripped everything away.

Probable Causes:

- Incorrect material design, causing excessive expansion.
- There is no expansion joint to absorb this expansion.
- When expansion occurs in the opposite direction, causing movement, this movement can compress the panel so much that it tears it away from the anchors.

Some corrective measures:

- ✓ Select the most suitable material that exhibits the least linear variation.
- ✓ Consider inserting an expansion joint after 3 or 4 panels to absorb some deformation.
- ✓ In the opposite (axial) direction, try to insert a metal plate or profile to act as a retainer and prevent the accumulation of variations.
- ✓ When expansion in the opposite direction causes movement, a retaining element is necessary to control that movement.

9) Cracking after setting:

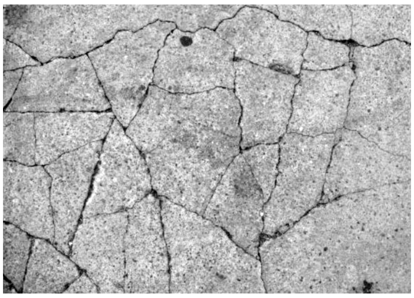
Observation: It may happen that after pouring and subsequent setting, the surface, upon removal of the formwork, is found to be entirely, or partially, full of very thin cracks.

Probable Causes:

- Excess water in the mix.
- Calculation based on bags of material and not the exact weight of the mix (the bags are uneven).
- Incorrect material selection.
- Excessive mixing time.

Some corrective measures:

- ✓ Follow the installation procedure for each product.
- ✓ Ensure that each batch is mixed with the correct percentage of water (measure the weight of the material in kilograms and the amount of water in kilograms).
- ✓ Do not overmix the material, i.e., do not overmix. This can make the mixture too fluid.



10) Shrinkage cracking:

Observation: After a certain period of use, the concrete surface is found to be covered with cracks that were not present during pouring and curing and appear after use. The cracks exhibit a classic quadriform pattern, typical of mechanical stress.

Probable Causes:

- Excessive heat input. The thermal expansion and contraction cause the refractory material to break into small pieces as it contracts.
- Incorrect concrete selection. It shrinks too much at that temperature.
- Kiln starting at too high a heating rate.

Some corrective measures:

- ✓ Select another product. Choose one that exhibits slight shrinkage or remains neutral at the oven's actual operating temperature.
- ✓ Check if the oven's operating temperature matches the process specifications, or if there is an error, or if overheating occurred at any point.
- ✓ Follow the oven manufacturer's recommended start-up curve, or check if any process parameters have changed.

11) Anchor Oxidation:

Observation:
Se visualiza el anclaje metálico de la oxidación de gas oxidante proveniente de la combustión.
Pueden encontrarse deformados o literalmente "quemados".
Probable Causes:

- The anchor is exposed to temperatures exceeding 1100-1150 °C. At this temperature, not even AISI 310 stainless steel can withstand the oxidation process. The iron oxidizes to ferric oxides, increasing the material's specific volume during this transformation. This deforms the anchor, which in turn breaks the surrounding refractory material. Furthermore, the anchor becomes embrittled (corrosive).

Some corrective measures:

- ✓ Verify that the oven process is functioning correctly and justifies the temperature in that area.
- ✓ Check that the stainless steel is of the highest possible quality.
- ✓ If the above is correct, then ceramic anchors should be used, as they are made of refractory material that can withstand those temperatures.

12) Concrete slippage in the anchoring zone:

Observation:
After removing the formwork and the concrete has set, it's noticeable that the cladding around the anchors (whether ceramic or metal) is slipping, lacking the proper grip that an anchor should have. This results in broken or fallen concrete around them.
Probable Causes:

- If ceramic bricks are not secured before pouring, they will move lengthwise and, after setting, will tend to return to their design position, pressing against the surrounding lining.
- Ceramic anchors have their upper portion (at the interface with the insulation) covered by this low-strength insulating material.
- Once the insulating material has been poured or shotcreted, the refractory anchors must be secured so that they are in the correct position according to the design, thus preventing them from moving afterward.
- In the case of metal anchors, it is essential to ensure that their ends are bent to a horizontal position, parallel to the lining. This bent portion of the anchor must also be covered with paper tape, plastic caps, or a bituminous coating to allow for the expansion of the metal, which is much greater than that of the refractory material. Cover approximately 25% to 33% of the anchor arm's length from the end to the fixing point.

Some corrective measures:

- ✓ Ensure that the top of the ceramic anchor (at the interface with the insulation) is free of the insulation and perfectly clean before being filled with refractory concrete. This area of the ceramic anchor can be covered with cardboard or another material.
- ✓ Secure the ceramic insulation (with wooden or ceramic fiber wedges) in the area where it attaches to the sheet metal using metal hooks, so that it is in its working position according to the design.
- ✓ Check the design of the metal anchors to ensure that their ends are bent and covered with a combustible material before proceeding with the refractory filling.

13) Surface landslides of the "crater" type:

Observation:
This effect, also known as spalling, usually appears during the drying process or initial heating of the oven, causing detachments in different areas in the form of a "crater", creating a totally irregular surface that needs to be repaired.
Probable Causes:

- As the temperature increases, the water contained in the concrete generates water vapor that in some areas cannot escape from the concrete layers, eventually escaping due to pressure that overcomes these areas, breaking the upper part in the form of craters.

Some corrective measures:

- ✓ During casting, create steam vents, either with wire inserts that are later removed, or by using plastic filaments or other methods such as perforating the surface, etc.
- ✓ Review the materials used: Nowadays, materials suitable for "rapid drying" are available, either because they contain fibers (which are later burned), or because they are cementitious materials that ensure no water is present in the mix (cement-free or chemically bonded concretes).
- ✓ Ensure that the drying curve is the one recommended by the concrete manufacturer. Often, kilns cannot precisely follow these curves, which significantly increases the drying rate in some sections.
- ✓ Use a "Convective Drying" service, where we can ensure that the temperatures throughout the refractory system correctly follow the recommended curve. In addition, convective drying uses dry air and not combustion gases (which also generate water during combustion), complicating the drying process. All refractory materials should use this type of drying.

14) Surface peeling of up to 2 inches during drying :

Observation:
After use, a detachment is observed on significant surfaces (not craters), which can also be interpreted as spalling, but it is very superficial (less than 5 cm) and appears as if the material was laminated and that layer did not bond or adhere to the rest of the concrete.
Probable Causes:

- Extremely rapid heating (especially from 0 to 200°C). The surface layer with higher water content evaporates quickly, and the vapor pressure separates it from the rest of the originally poured concrete.
- A surface application to improve the finish (troweling), adding small amounts of a thinner, more watery material (to improve appearance).
- A thin, unanchored repair over old material, also with a higher water content.

Some corrective measures:

- ✓ Review the heating curve, especially during the first stage.
- ✓ Use **convective drying** instead of oven burner drying to strictly adhere to the recommended curve.
- ✓ If you want to improve the surface after removing formwork or repair an old coating, use materials appropriate for this type of finishing.

15) Layer lamination:

Observation: Luego del uso, se observan zonas importantes, de mayores profundidades que se han caído mientras las linderas están sin problemas. No son ni cráteres, ni desprendimientos superficiales.
Probable Causes :

- Time may have been taken between sections during installation by casting or injection. This prevents the entire surface from acting monolithically, as adhesion between sections is not optimal.
- The area to be covered may be too large, requiring multiple mixes and resulting in delays between mixes while the material sets.

Some corrective measures:

- ✓ In these cases, first, it is necessary to divide the wall into panels (max 1-1.2 m² each) arranged in a line and proceed to fill them in a "checkerboard" pattern, that is, pouring or injecting panels alternately, and once those have set, filling the remaining unfinished panels.
- ✓ Implement convective drying.

16) Deformed and/or broken ceramic anchors:

Observation: The ceramic anchors (usually called dummy anchors) are found broken, cracked, or missing a piece of the hot side. At first glance, these elements appear to have been subjected to a force greater than expected, causing them to break or fracture. This is due to mechanical stress.

Probable Causes:

- An unexpected explosion during kiln combustion (perhaps due to irregular combustion).
- That the anchors were accidentally struck before use. Remember, these are ceramic pieces.
- That their installation and design are incorrect.
- That they cannot withstand thermal shock during kiln operation.

Some corrective measures:

- ✓ Check the kiln for explosions or incomplete combustion, and ensure the packaging shows no signs of accidental drops or impacts.
- ✓ The installation design should allow for some movement of the anchor (at the top, via the fasteners), ensuring they are free within the concrete. The top of the anchor is often wrapped, approximately halfway, with ceramic fiber insulation. This improves the anchor's movement and enhances its resistance to thermal shock.
- ✓ Selecting the highest quality ceramic anchors is crucial.

17) Joints too large:

Observation: It is observed that after use, the joints between panels are left too open, which had already been warned through the rise in the temperature of the sheet metal, since this opening allowed the passage of heat towards the side of the equipment casing.

Probable Causes:

- Incorrect design. The distance between joints is too large. This causes the material to contract throughout the joint, leaving a larger opening than desired.
- Incorrect use of joint materials means that as soon as the joint opens slightly, the material used in it comes out or is lost.
- The use of concretes that exhibit excessive linear shrinkage at the temperature used.The use of concretes that exhibit excessive linear shrinkage at the temperature used.

Some corrective measures:

- ✓ The panels should be designed so that the joints are spaced appropriately. Each panel should not exceed 1.2 m², ideally with a rectangular shape. This will prevent excessive joint size after material contraction.
- ✓ If compensation joints are used, employ ceramic fiber materials that maintain their resilience at the design temperature.
- ✓ Select concrete that does not exhibit moderate linear compression variations.

18) Desgastes prematuros en zonas cercana a la llama:

Observation: After a short time, a reduction in the refractory profile of the furnace burners becomes visible, indicating wear from flame erosion or dust swirling around the flame zone. This will necessitate replacing the burner block and risks further deterioration of the burner itself, reducing its lifespan.

Probable Causes:

- The burner block is of inadequate quality (material, drying or firing process, manufacturing procedure, etc.).
- The block is incorrectly anchored to the furnace and allows movement.
- There is a problem in the firing system causing unexpected explosions or vibrations.

Some corrective measures:

- ✓ Castable selection: It must withstand high thermal shock stresses (medium alumina, low cement, cement-free). The type of raw material used is important.
- ✓ Check the anchoring system. It must be securely fastened and have an appropriate expansion joint to allow for minimal readjustment.
- ✓ Check the proper functioning of the fire suppression system.

19) Hot spots on the furnace shell:

Observation:
This is one of the failures where it's most difficult to find a root cause, since in many cases, if we detect several hot spots on the sheet metal, they aren't necessarily due to a single cause, but rather there are likely different causes at different points. The appearance of these hot spots is always a cause for alarm in thermal equipment, as it can signify the end of the coating and the urgent need for replacement, although sometimes there are mitigating measures that allow for extending the service life.

Probable Causes:

- Localized spalling of the concrete coinciding with the hot spot.
- Localized reduction in the thickness of the insulating concrete or other insulation used. This alters the thermal profile at that point. Detached or unwelded anchors. This creates an open space between the anchor and the sheet metal, which is filled by the hot gas. Poorly selected or designed concrete (insulating and refractory), which causes insufficient resistance in the insulation, leading to its collapse and the creation of voids filled by the hot gas.

Some corrective measures:

- ✓ When installing both layers (insulation and refractory material), the thicknesses specified by the manufacturer must be respected. The insulation-to-refractory ratio should be adjusted according to changes in the internal temperature, always leaning towards the more conservative side.
- ✓ Check the installed anchors and their strength.
- ✓ Review the material selection, especially for the insulation.
- ✓ In some cases, quick repairs can be made to continue operations if the hot spot has been identified and the problem cannot be extrapolated to the entire refractory layer.
- ✓ In some cases of insulation deterioration, the metal sheet can be drilled and insulating materials (injectable ceramic fiber) injected to quickly resolve the issue.

20) Scab or crust formation :

Observation: In various industries (cement, petrochemical, chemical, etc.), the combination of combustion processes with the residues entering the gases causes these residues to stick together, forming a crust of varying thickness and length. Depending on the nature of this crust, it can cause alterations in the flame or damage to the kiln's insulation, potentially reducing its efficiency.

Probable Causes:

- Scale forms in areas where combustion gas mixes with process dust, swirls, and adheres to the wall, melting upon contact with the hot surface.
- Variations in flame length, or sometimes the type of fuel used, can determine the amount and location of scale formation. This changes when conditions are altered again.
- Sometimes, problems with high oxidation, or conversely, reducing flames, can affect the surface of refractories not designed to withstand these changes.

Some corrective measures:

- ✓ Understanding the cause of crust formation in the kiln is crucial. This can lead to urgent contingency measures being taken, or simply to no action being taken at all.
- ✓ Once the crust formation mechanism is identified, check if the refractory materials used are designed to withstand that effect.
- ✓ Investigate the effect of flame length, fuel used, process speed, raw materials used, etc., and their correlation with the location and thickness of the crust. This understanding will allow for regulating crust formation, minimizing it, relocating it to less hazardous areas, or at least determining its cause.

Conclusions:

There are **undoubtedly many more failures or problems** than those listed here, but we have focused on the 20 most common. Of course, each industrial sector sees more problems of one type than another. The important thing to note is that in most cases, reviewing the design specifications and, above all, the materials being used are among the planned solutions.

This is where we believe **Soluciones Refractarias SRL** comes in, to solve and repair these failures.

Our company has all the necessary resources to address these issues:

- ✓ Top-tier technical advice.
- ✓ State-of-the-art materials.
- ✓ Cladding design and thermal calculations.
- ✓ Installation of various materials.
- ✓ Convective hot air drying.

Our WEB : www.solucionesrefractarias.com.ar

Our social nets : https://taplink.cc/solucionesrefractarias

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Related Links:

Installation service :
Heat flow calculations
Installation Procedures
Explosion of a refractory (UNLP)
Drying curves
Convective drying of refractory castables
Specific products for insulation.
Specific products for Fast dry-out.

Note: This report aims to illustrate all aspects and complexities of the topic covered. It should not be taken literally for decisions regarding values or absolute final results within the scope of the report. For specific calculations or decisions, we recommend consulting specific sources.
Sources: Our own research, information published by manufacturers, universities, and other sources.

All aspects concentrated in one place, our space !!!!

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