

Refractory Ceramics Challenge!



Funded by
the European Union

How to play

Setup: Shuffle the deck and deal all the cards evenly to each player, face down.

Starting the Game: The first player looks at their top card and chooses a category (e.g., Life-time, Cost, etc.) they think will be higher than that of the other player's.

Compare Values: All players reveal their top card and compare the chosen category's value.

Winning the Round: The player with the highest value wins the round and takes all the revealed cards, placing them at the bottom of their pile.

Next Turn: The winner of the round chooses the category for the next round.

Continue Playing: Repeat steps 2-5 until one player has all the cards or players decide to stop.

Winning the Game: The player with all the cards or the most cards at the end wins.

Enjoy your game!



CESAREF

The European Union, through the Marie Skłodowska-Curie Actions (MSCA), is funding 15 PhD candidates to carry out research into increasing the sustainability of refractory ceramics in industrial applications. Supported by leading academic and industry experts, these researchers will apply advanced techniques to help multiple energy intensive industries reach NetZero by 2050.

The CESAREF project tackles this through four key areas: Life Cycle Assessment, fundamental materials research, the impact of hydrogen use and machine learning. Cutting-edge methods, from synchrotron science to real-world model validation, will drive innovation in sustainable refractories.

You can find out more on our website.

Enjoy your game!



Ceramics, not only useful in the kitchen

Refractory ceramics have a surprising and vital role in modern industry due to their ability to withstand extreme heat, corrosion and wear. Energy intensive industries such as steel, glass, cement, power generation, petrochemicals and aerospace all rely on refractory ceramics to operate in extreme environments ensuring safety, efficiency and durability of critical equipment.

From the lining of steel ladles to thermal protection systems on space shuttles, or from glass production to use as ablative armour, refractory ceramics have an extremely wide set of uses. The impact of ceramics on our daily lives is much more profound than we are aware of!

In this game we are sharing just a few of the usual and unusual places you can find ceramics. Find out more on our website.

Enjoy your game!



Stats

On each card you will find some stats related to the ceramic object on the card. These are the following:

Lifetime : This value represents the average length of time an object can be reasonably expected to last on a scale of 1 - 100.

Cost : An average, reasonable cost has been determined for each ceramic and assigned a value between 1 - 100. Where multiple ceramics are used to complete an item (e.g. bricks in a ladle) the total cost of the item is used.

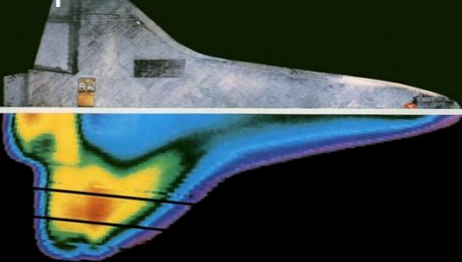
Daily impact : On a scale of 1 - 100, how this ceramic item impacts your daily life.

Resistance : On a scale of 1 - 100. Ceramics are highly resistant to heat, chemicals and physical stress. This value indicates globally how resistant a material is.

Max. Temp. : On a scale of 1 - 100. The highest temperature the material can be used at for a prolonged period of time.

Enjoy your game!

Space Shuttle Shield



Lifetime	28
Cost	100
Daily impact	8
Resistance	85
Max. Temp.	1650 °C

Ceramic tiles are essential to the thermal protection of space craft, providing insulation against the extreme heat of re-entry. Each space shuttle has 24,300 tiles which are designed to survive a round trip to space 100 times.

Crucible: Metal Casting



Lifetime	58
Cost	18
Daily impact	42
Resistance	30
Max. Temp.	1300 °C

A high-temperature-resistant vessel used to melt metals for casting jewellery for example. Made from materials such as clay-graphite or silicon carbide, crucibles withstand extreme heat during metal processing in foundries and laboratories.

Zirconia Crucible for Platinum Melting



Lifetime	56
Cost	18
Daily impact	42
Resistance	78
Max. Temp.	1650 °C

Withstands extreme temperatures and resists chemical attack, making it ideal for melting platinum. Its stability ensures purity, prevents contamination, and supports efficient, repeated use in high-temperature platinum refining and casting processes.

Glassblowing Pot (Clay-Based)



Lifetime	76
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Cost	63
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Daily impact	45
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Resistance	76
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Max. Temp.	1750 °C
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A refractory clay vessel used to melt and hold glass at high temperatures. Made from special fireclays, it resists thermal shock, corrosion and deformation, ensuring purity and durability during repeated heating cycles in glassmaking furnaces.

Kiln Shelves



Lifetime	82
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Cost	8
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Daily impact	56
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Resistance	100
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Max. Temp.	1600 °C
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Silicon carbide kiln shelves are durable, high-strength platforms used in kilns for firing ceramics and pottery. They resist warping, corrosion and glaze spills. Their low porosity and lightweight design make them ideal for repeated kiln use.

Kiln Firing Support (Cordierite)



Lifetime	84
Cost	6
Daily impact	87
Resistance	65
Max. Temp.	1300 °C

Roofing tiles are dried on specially designed shelves which enable consistent heating conditions throughout the kiln. These shelves also enable a high degree of automation.

Blast Furnace Lining



Lifetime	66
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Cost	53
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Daily impact	46
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Resistance	72
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Max. Temp.	1600 °C
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A blast furnace is a large, vertical, steel structure used to extract iron from iron ore. It chemically reduces ore at high temperatures into molten iron. The lining of a blast furnace is made of thick, high-quality refractory bricks to protect the furnace shell from extreme heat.

Refractory Cement



Lifetime	74
Cost	18
Daily impact	75
Resistance	83
Max. Temp.	1750 °C

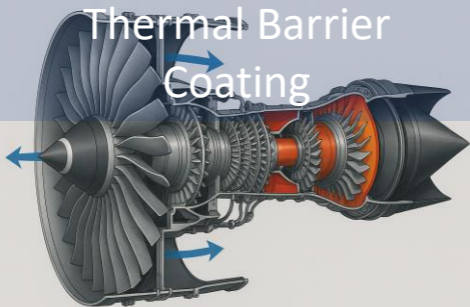
Essential for lining furnaces, kilns, fireplaces and other high-temperature industrial applications. It is a binding material, primarily made from calcium aluminate, designed to withstand extreme temperatures.

Incinerator Brick



Lifetime	725 years
Cost	54
Daily impact	50
Resistance	75
Max. Temp.	1700 °C

Incinerator linings protect furnace walls from extreme heat, corrosion, and abrasion. They improve energy efficiency, extend equipment life, and ensure safe, stable combustion in waste treatment and industrial processes.



Lifetime	38
Cost	50
Daily impact	16
Resistance	95
Max. Temp.	2200 °C

Ceramics in gas turbines are used as thermal barrier coatings on turbine blades. These coatings insulate metal components from extreme heat, allowing higher operating temperatures and improving engine efficiency and durability.

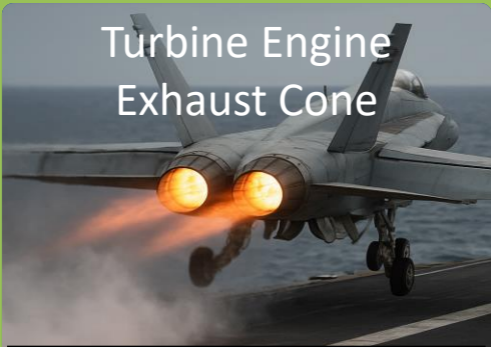


Rocket Nozzle (Ablative Ceramic)

Lifetime	26
Cost	63
Daily impact	6
Resistance	40
Max. Temp.	3000 °C

Ablative ceramics are used in rocket nozzles as a heat shield. As the hot exhaust gases pass through the nozzle, the ceramic material gradually vaporizes, absorbing and dissipating heat. This protects the nozzle and prevents failure.

Turbine Engine Exhaust Cone



Lifetime	40
Cost	63
Daily impact	18
Resistance	86
Max. Temp.	2000 °C

Ceramics such as alumina, aluminosilicate and SiC provide high-temperature resistance, lightweight durability and corrosion resistance, enhancing engine efficiency and lifespan in extreme exhaust environments.

Armor Plate



Lifetime	95
Cost	63
Daily impact	3
Resistance	88
Max. Temp.	2000 °C

Hard ceramic tiles (alumina, silicon carbide, boron carbide) that fracture projectiles are backed by composites for energy absorption. They provide lightweight, multi-hit protection against armour-piercing bullets.



Refractory Ceramic Foam Filter

Lifetime	10
Cost	1
Daily impact	34
Resistance	76
Max. Temp.	800 °C

Porous, heat-resistant filters made from materials like alumina, silicon carbide, or zirconia. Used in metal casting, they remove impurities from molten metals, withstand high temperatures due to their open-cell, foam-like structure.

Food grade filters



Lifetime	12
Cost	10
Daily impact	62
Resistance	8
Max. Temp.	500 °C

Porous, ceramic filters are used throughout the food industry to improve the clarification of liquids such as coconut water or wine. They also remove harmful microorganisms.

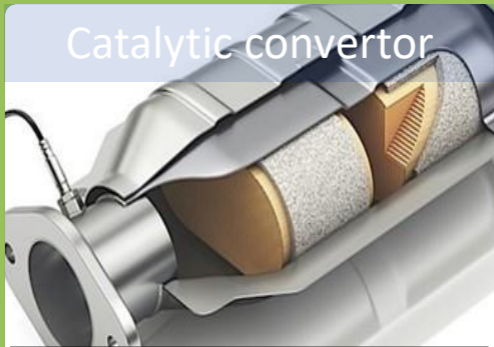
Ladle Lining



Lifetime	64
Cost	52
Daily impact	22
Resistance	90
Max. Temp.	2800 °C

High-alumina and mullite-based refractories provide thermal insulation, resist abrasion and chemical attack, extend ladle life, and maintain molten metal temperature, ensuring clean and efficient transfer during casting.

Catalytic convertor



Lifetime	71
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Cost	11
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Daily impact	95
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Resistance	68
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Max. Temp.	800 °C
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Refractory ceramics form honeycomb substrates in catalytic converters, providing heat resistance, mechanical strength and large surface area for catalysts. They ensure efficient gas flow, withstand harsh exhaust conditions and enable effective emissions control.

Kiln insulation blanket



Lifetime	78
Cost	30
Daily impact	58
Resistance	26
Max. Temp.	1200 °C


High-purity alumino-silicate fibers, are used in kiln insulation blankets to provide lightweight, flexible, non-combustible insulation that withstands extreme temperatures, minimizes heat loss and resists thermal shock.

Toilet bowl (Porcelain)



Lifetime	98
Cost	6
Daily impact	100
Resistance	52
Max. Temp.	60 °C

Made from clay, feldspar, and quartz, toilet bowls are moulded and kiln-fired to create hard, non-porous, water-resistant, easy to clean, durable and sanitary products. Its strength and low water absorption is ideal for bathroom use.



BBQ ceramic briquettes

Lifetime	88
Cost	3
Daily impact	64
Resistance	22
Max. Temp.	200 °C

Ceramic briquettes improve BBQ grill efficiency by absorbing and radiating heat evenly across the cooking surface, eliminating hot and cold spots for consistent cooking. They withstand high temperatures, repeated heating cycles and rough handling.

Glass-Ceramic Fireplace Panel



Lifetime	90
Cost	8
Daily impact	74
Resistance	58
Max. Temp.	800 °C

High heat resistance, near-zero thermal expansion and clear flame viewing, ensuring safety, durability, and efficient heat radiation while allowing an unobstructed view of the fire.

Cordierite Pizza Stone



Lifetime	94
Cost	2
Daily impact	70
Resistance	91
Max. Temp.	1300 °C

Ceramics are used in pizza stones for their excellent heat retention, even heat distribution and resistance to thermal shock. Their porous structure absorbs moisture from dough, producing crispier crusts and they withstand rapid temperature changes without cracking.

Zirconia Dental Crown



Lifetime	86
Cost	11
Daily impact	85
Resistance	78
Max. Temp.	1000 °C

With their exceptional strength, durability, biocompatibility and minimal tooth preparation, ceramics are ideal for long-lasting, metal-free restorations that withstand heavy chewing forces and give a natural appearance.

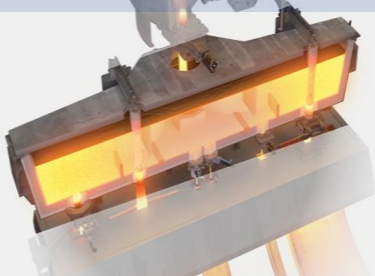
Spark Plug Insulator



Lifetime	78
Cost	1
Daily impact	78
Resistance	50
Max. Temp.	1000 °C

Due to their excellent electrical insulation, high thermal conductivity and strength, ceramics are used in spark plugs as insulators. They ensure reliable spark delivery, prevent flashover and dissipate heat.

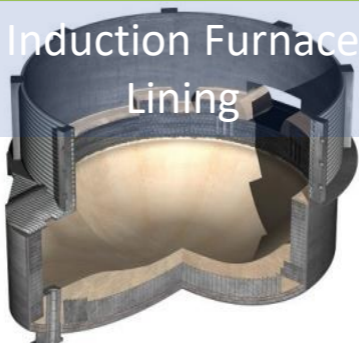
Tundish Lining



Lifetime	62
Cost	54
Daily impact	45
Resistance	90
Max. Temp.	2800 °C

Ceramics are used in steel mill tundish linings to insulate, resist thermal shock, prevent heat loss, minimize contamination, and extend vessel life during molten steel transfer in continuous casting operations.

Induction Furnace Lining



Lifetime	52
Cost	50
Daily impact	32
Resistance	90
Max. Temp.	2800 °C

An electrical furnace that melts metals using heat generated by electromagnetic induction. It offers clean, energy-efficient, and well-controlled melting for various metals, without combustion or arc and is widely used in modern foundries for precise alloy production.



Graphite Furnace Electrode

Lifetime	54
Cost	38
Daily impact	38
Resistance	88
Max. Temp.	2500 °C

Used in electric arc furnace as a carbon source and conductor for steelmaking. Electric arc furnaces refine iron and produce steel, providing the heat necessary to melt iron ore, remove impurities from the molten iron product and create slag.

Ceramic Ball Bearings



Lifetime	85
Cost	3
Daily impact	1
Resistance	71
Max. Temp.	1000 °C

Lightweight, vacuum-compatible, non-magnetic, wear and temperature resistant, ceramic bearings are ideal for use in applications such as satellites, spacecraft, medical equipment, electric vehicles and industrial equipment.

Ceramic BBQ Grill



Lifetime	92
Cost	10
Daily impact	66
Resistance	80
Max. Temp.	600 °C

A Kamado is a traditional ceramic charcoal grill and smoker known for excellent heat retention, even cooking and versatility, allowing grilling, smoking, and baking with efficient fuel use and precise temperature control.

Infrared Ceramic Heater Element



Lifetime	14
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Cost	3
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Daily impact	80
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Resistance	78
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Max. Temp.	700 °C
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Providing efficient, uniform heat emission, excellent thermal stability and rapid heating capabilities. Their resistance to oxidation and corrosion ensures long service life, making them ideal for industrial, commercial and domestic heating applications.

Bulletproof vest



Lifetime	95
Cost	15
Daily impact	3
Resistance	88
Max. Temp.	1000 °C

Ceramic inserts provide a hard, lightweight barrier that shatters and disperses the energy of incoming projectiles, reducing penetration and spreading impact force over a wider area, significantly increasing protection and reducing injury risk for the wearer.

Kiln Wall Refractory



Lifetime	80
Cost	50
Daily impact	60
Resistance	93
Max. Temp.	1700 °C

Tunnel kilns are elongated, continuously operating furnaces used in the mass production of ceramic products. Ceramics are loaded onto cars that move through different temperature zones, allowing for efficient, consistent firing.

A photograph of a ceramic infrared sauna heater installed in a wooden sauna. The heater is a vertical, rectangular unit with a black frame and a red glowing ceramic element. It is mounted on a wooden wall. In the foreground, there are wooden sauna benches. The text "Ceramic Infrared Sauna Heater" is overlaid in white on the top half of the image.

Ceramic Infrared Sauna Heater

Lifetime	20
Cost	11
Daily impact	50
Resistance	14
Max. Temp.	400 °C

Sauna heaters emit gentle, consistent infrared heat, penetrating the skin for deep warming, promoting relaxation. Their ceramic elements ensure efficient energy use, durability and even heat distribution for a comfortable sauna.



Porcelain Insulator for Power Lines

Lifetime	100
Cost	4
Daily impact	93
Resistance	82
Max. Temp.	300 °C

Ceramics provide excellent electrical insulation, resist weathering, mechanical stress and withstand high voltages, ensuring safe and reliable transmission of electricity by preventing current leakage and maintaining structural integrity.

Ceramic Coffee Mug



Lifetime	96
Cost	1
Daily impact	98
Resistance	50
Max. Temp.	200 °C

Good heat retention, durability, non-toxic and easy to clean make ceramic mugs the go to choice for tired parents through to students studying late at night.



Refractory Brick for Wood-Fired Oven

Lifetime	76
Cost	18
Daily impact	72
Resistance	76
Max. Temp.	200 °C

These bricks line cooking chambers, providing insulation to retain heat, structural support to withstand thermal stress and protection against intense fire. These specialized bricks ensure efficient, consistent cooking temperatures for optimal culinary results.

Jet engine turbine mould



Lifetime	36
Cost	38
Daily impact	15
Resistance	85
Max. Temp.	1260 °C

Ceramic moulds in investment casting create precise turbine blades with complex internal structures. The process forms single crystal nickel superalloys that withstand extreme temperatures, using detailed shells that are removed after metal pouring and before finishing.

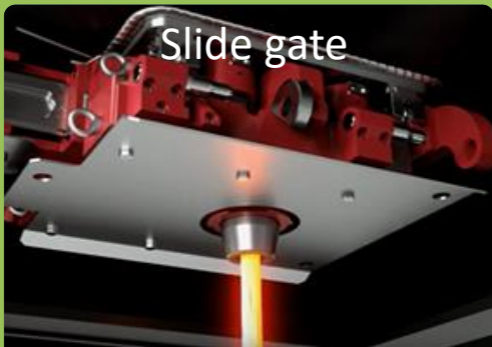


Purging plug

Lifetime	46
Cost	25
Daily impact	26
Resistance	72
Max. Temp.	1600 °C

Inert gases are injected into molten steel, through the bottom of the ladle, to promote mixing, temperature control and impurity removal. Purging plugs withstand extreme heat while enhancing steel quality and refining efficiency.

Slide gate



Lifetime	48
Cost	30
Daily impact	28
Resistance	98
Max. Temp.	1650 °C

Slide gates control flow of molten steel from the ladle. Two ceramic plates slide over each other to open and close the outlet. They provide temperature resistance, erosion protection, chemical stability and enable precise pouring control while minimizing maintenance.

Torpedo Cars



Lifetime	44
Cost	66
Daily impact	24
Resistance	70
Max. Temp.	1600 °C

Hot molten metal is moved between the blast furnace and steelmaking plant via a railway. Insulated cars, shaped like torpedo's, have refractory ceramic linings which retain heat, resist wear and ensure safe and efficient molten metal transport.

Thermal regenerator



Lifetime	34
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Cost	57
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Daily impact	14
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Resistance	32
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Max. Temp.	700 °C
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Refractory ceramics store and release heat efficiently at high temperatures, offering rapid heat absorption and insulation. They enhance energy storage, durability and efficiency, supporting sustainable renewable energy and industrial heating applications.

Glass float bath

tin bath
2000°F

Lifetime	70
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Cost	79
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Daily impact	44
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Resistance	96
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Max. Temp.	1900 °C
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Glass is formed by floating molten glass onto a bath of molten tin. It spreads and flattens under gravity and surface tension, creating a smooth sheet. Refractory ceramics line the tin bath ensuring quality glass while boosting efficiency, durability and lifespan.



Rotary kilns

Lifetime	68
Cost	61
Daily impact	48
Resistance	93
Max. Temp.	1500 °C

Enabling the continuous thermal treatment of materials rotary kilns are used in various industries for high-temperature processing. For example, cement, lime, calcination of minerals, waste incineration and the production of chemicals, ceramics and metals.

Ceramic brakes



Lifetime	83
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Cost	11
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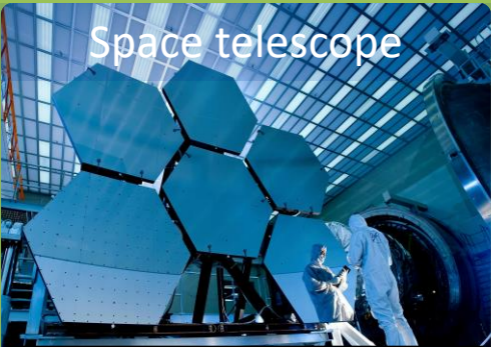
Daily impact	83
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Resistance	75
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Max. Temp.	1600 °C
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Carbon-ceramic brakes combine carbon fibres with silicon carbide for superior stopping power. They offer exceptional heat resistance, reduced weight, consistent performance under extreme conditions, longer lifespan, and less brake dust.

Space telescope



Lifetime	24
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Cost	83
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Daily impact	3
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Resistance	100
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Max. Temp.	2000 °C
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Silicon carbide (SiC) mirrors offer high stiffness, low weight and excellent thermal stability, making them ideal for space telescopes requiring precise imaging and durability in extreme environments.