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Ceramic coating in the automotive and aircraft industries and the role of sodium silicate in ceramic production and export.

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ABSTRACT

Ceramic hard coatings are one of the most important and widely used innovations in the manufacturing and automotive industries. These coatings have attracted great attention due to their unique properties, including high hardness, wear resistance, and ability to withstand very high temperatures. Ceramic hard coatings have many advantages that make them a suitable choice for various industries. Some of these advantages include:

Hardness and wear resistance: Ceramic coatings can have high hardness and are therefore very resistant to wear. Heat resistance: These coatings are able to withstand high temperatures and are therefore very effective in thermal applications.

Chemical resistance: Ceramic hard coatings are resistant to chemicals and corrosion. As an innovative and efficient technology in the manufacturing and automotive industries, ceramic hard coatings offer many advantages. However, to maximize these benefits and reduce the challenges, it is necessary for manufacturers and engineers to continuously work on improving the processes and techniques associated with these coatings.

In this article, we have also examined the role of sodium silicate

Use of sodium silicate as an adhesive

Improving the physical and chemical properties of ceramic tiles

Increasing quality and improving the production process
Application in ceramic tile glazing

Finally, it is recalled that ceramics are exported from Iran to Russia, Turkey, Georgia, Armenia, Pakistan, Azerbaijan, the Emirates, Oman, Kuwait, Iraq and Turkmenistan. Some European countries are also interested in purchasing ceramic tiles from Iran.

Keywords: Ceramic export, Automotive and aircraft industries, sodium silicate

INTRODUCTION

Iranian ceramics, with its long and rich history of artistic and industrial achievements, have a distinguished place on the world stage. The technical expertise and artistic design in the production of Iranian ceramics, as one of the cultural symbols of the country, have attracted international attention. This industry not only has a special place in the production of artistic and historical works, but also plays an important role in various sectors, including construction. Iranian ceramic production in the world has a special place among all the world's leading manufacturers due to the combination of rich historical culture and high technical expertise, and due to the integration of Iranian art in the production of this product. As mentioned above: Iran is one of the Middle East countries that has many mines and resources in itself.

Ceramics are not only for traditional industries or containers; today they have played a key role in the automotive world. From ceramic coatings on the body of the car to ceramic parts in brakes and sensors, these materials increase the life and efficiency of the car. Even in some modern cars, alumina parts are used to increase thermal and mechanical resistance. For this reason, many companies operate as ceramic parts manufacturers or providers of custom ceramic parts manufacturing services.

Automotive Ceramic Coatings

The automotive industry is one of the vital industries in modern societies and has always been striving to improve the efficiency and quality of cars. In this regard, the use of new and innovative materials to improve the characteristics of cars is of great importance. One of these innovative materials is ceramics, which is widely used in the automotive industry due to its extraordinary properties. In this article, we will examine the use of ceramics in the automotive industry and its innovations and potential.

Car body:

The use of ceramics in car bodies can bring significant improvements in the efficiency and safety of cars. Due to their hardness and high resistance to damage and corrosion, ceramics can increase the strength of the car body and thus improve travel safety. Also, ceramics can reduce the weight of the vehicle due to its lighter weight than steel, and thus improve fuel efficiency.

Brakes:

Ceramics can be used in vehicle brakes due to its high heat resistance. Ceramic brakes perform better than traditional brakes due to their high thermal insulation properties, high corrosion resistance, and longer life. Also, ceramics can reduce the weight of brakes due to their lighter weight than steel, and thus improve brake performance.

Engine:

Ceramics can be used in internal engine parts due to their high thermal insulation properties and resistance to heat and pressure. Using ceramics in engine parts can increase engine efficiency, reduce wear, and increase its useful life. Also, ceramics can reduce the weight of engine parts due to their lighter weight than steel, and thus improve fuel efficiency

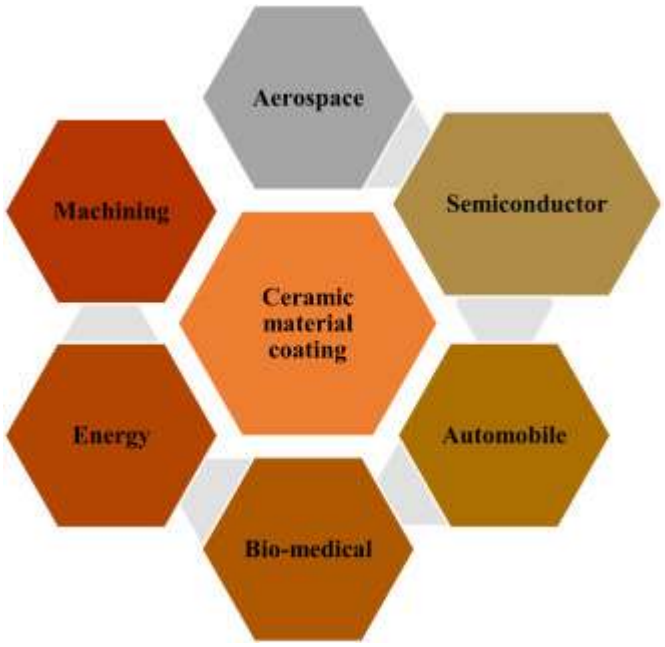
Automotive Electronics:

Ceramics can be used in automotive electronic components due to their high electrical insulation and heat resistance. Using ceramics in electronic components can help reduce the possibility of thermal failure and increase their stability and useful life.

One of the most important applications of ceramics in the automotive industry is protective coatings on the body. After being applied to the car's paint, the ceramic coating creates a transparent and resistant layer that, in addition to enhancing its beauty, protects the body from scratches, UV rays, and harsh weather conditions.

These coatings are mainly made of silicon dioxide (SiO_2) and have high hydrophobic properties. For this reason, raindrops and dirt stick more tightly to the body. Some more advanced products also gain greater adhesion and flexibility by adding titanium and polysiloxane.

Table 1: Shows the various applications of ceramics



The best ceramic coatings on the market

• Carbon Force (Chemical Guys) A gel-like coating with high thickness and excellent durability.

• Adam's Graphene Ceramic Coating: Graphene coating with excellent shine and short drying time.

• Cerakote Rapid: The most economical option with a thin texture and easy application.

Ceramic sensors in cars

One of the important areas of use of ceramics is car sensors. These sensors are made using high-voltage electrical insulating ceramics and are very resistant to heat, moisture and vibration. For example:

• The tire pressure sensor uses ceramics to inform the driver of a drop or increase in pressure.

• The oxygen sensor in the combustion chamber helps improve engine performance.

• Impact and parking sensors are used for greater safety and control of the car.

• Also, some components such as ceramic spark plug insulators or even ceramic car spark plugs are clear examples of the use of ceramics in car electrical systems.

New Generation Car Parts

Advances in ceramics have improved the thermal management of modern cars. This plays an important role in increasing the life of batteries, electric motors, and even lithium battery cooling systems.

Some of the most important ones include:

• Use of ceramic nozzles in fuel injectors for greater resistance to high temperatures.

• Use of alumina and zirconia components in the mechanical parts of the car to increase strength.

• Zirconia thermal insulators in the combustion chamber that minimize heat transfer.

Table 2: Comparison of brake pad types



نوع لنت ترمز	مزایا	معایب	کاربرد اصلی
سرامیکی	اصطکاک پایدار، صدای کم، گرد و غبار کمتر، سبک وزن، تحمل دمای بالا	قیمت بالا، بیشتر مخصوص خودروهای لوکس و اسپرت	خودروهای لوکس و سوپراسپرت
نیمه‌فلزی	قیمت مناسب‌تر، انتقال کمتر گرما نسبت به تمام‌فلزی، عملکرد خوب	صدای زیاد، سایش بیشتر دیسک، تولید گرد و غبار زیاد	خودروهای عمومی و عملکردی
کربن-سرامیکی	سبک وزن، عمر طولانی، تحمل دمای بسیار بالا (تا ۱۰۰۰ درجه)، عملکرد عالی	قیمت بسیار بالا، بیشتر در خودروهای خاص و مسابقه‌ای استفاده می‌شود	خودروهای مسابقه‌ای و سوپراسپرت‌های خاص

Types of brake pads

Ceramic: The best choice for luxury cars, low noise and long life (1).

Semi-metallic: More economical but noisier and more abrasive.

Carbon-ceramic: Specially for sports and racing cars such as Lamborghini and Ferrari.

The introduction of ceramic parts into the automotive industry has brought about a major revolution. From body cladding to ceramic nozzles in injectors, from ceramic spark plugs to brake pads, all of these have improved the efficiency, durability and safety of the vehicle.

Ceramic component manufacturers such as Noorgra Ceramic Technology or custom ceramic component manufacturing services are playing a significant role in this industry today, and the future of smart and electric vehicles will increasingly depend on these materials.

Using Ceramics in the Aerospace Industry

The aerospace industry, and especially companies that manufacture commercial aircraft, have never been under such pressure to reduce costs while fully complying with safety regulations and increasing efficiency, based on a focus on net profit. This also includes the defense and space exploration sectors. Industrial ceramics such as alumina, silicon nitride, and alumina nitride play an important role in aircraft control devices and systems, engine status displays, missile control systems, and satellite positioning equipment. They are also used in combustion systems, fire suppression, and to protect turbine engines from corrosive gases. Aerospace manufacturers use a variety of brass alloys in the construction and repair of gas turbine engines. An example is the use of preformed and sintered brass parts at high temperatures. When the turbine temperature reaches more than 1300°C and the presence of corrosive gases causes wear and tear in the parts, the preformed and sintered parts contain a mixture of superalloy and low-melting brass, which is temporarily welded in place and then soldered. Due to the ability of this method to provide thicknesses close to the desired thickness of the part, there is no need for machining or turning after soldering, and the life of the engine parts is increased by up to 300%. For this reason, this method is very economical and reliable compared to conventional welding. Also in the OEM and DER approved process, PSP repairs are widely used in smaller aircraft engines where wear occurs due to frequent short-haul flights. Economical travel is not limited to commercial or defense flights. Morgan Industrial Ceramics in Erlangen, Germany, has been collaborating with the European Space Agency (ESA) for several years to research ion propulsion systems. Compared to chemical propulsion, ion engines have the potential to launch spacecraft ten times faster and over longer distances (per kilogram of fuel). Ion propulsion technology uses electricity to charge heavy gas atoms so that the atoms accelerate the spacecraft to very high initial velocities and propel it forward. Initially, the atom exit channels were made of quartz, but then alumina replaced quartz, as a material with the same dielectric properties but greater structural stability was needed. Alumina is easier to fabricate and has high thermal shock resistance

Self-repairing ceramic for aircraft engines

Japanese researchers claim to have developed a ceramic material that repairs cracks in just a minute, and could significantly change manufacturing methods for the transportation industry. The team, from the National Institute for Materials Science (NIMS) and Yokohama National University in Japan, say the material could be used in aircraft engines to maintain their operation even when they are damaged by flying objects.

“When an aircraft engine cracks during flight, this ceramic material will enable the aircraft to repair itself before landing without stopping,” says researcher Toshio Osada. Wataru Nakao, a professor of engineering at the university, notes that the material “could be used for a wide variety of products,” and the team is planning studies to commercialize it (3, 4). Ceramic engines have been seen as a possible way to improve fuel efficiency because they are lighter and more heat-resistant than nickel and titanium, but they have been considered too brittle for use in aircraft engines. To solve this problem, the researchers added silicon carbide to a ceramic material made of aluminum oxide. When the ceramic cracked at high temperatures, the silicon carbide was exposed to air and converted to silicon dioxide, which filled the crack and repaired the damage (Figure 1).

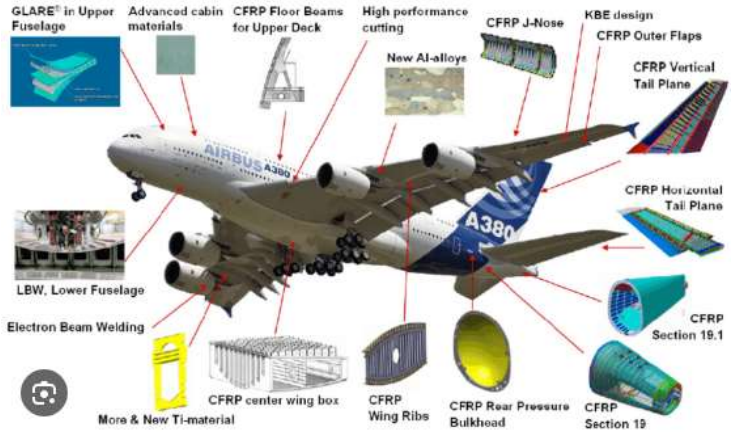


Figure 1: Use of ceramics in aircraft



Figure 2: Use of ceramics in the aerospace industry

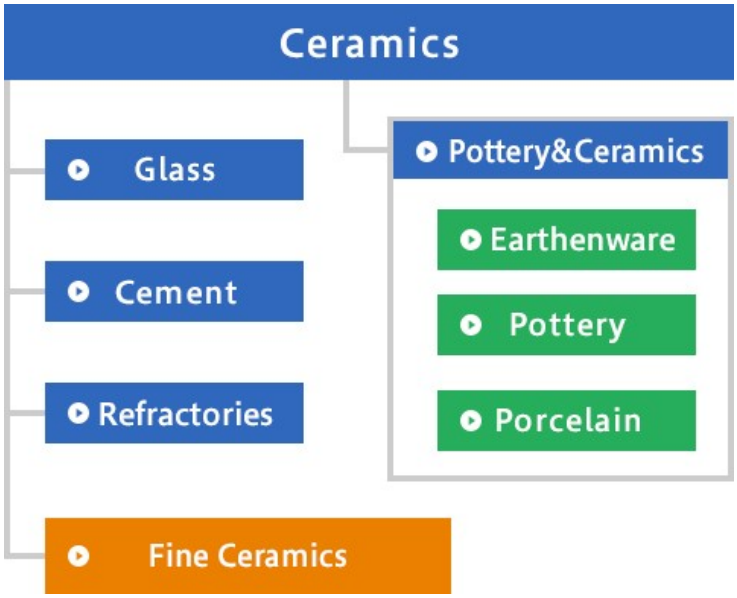


Figure 3: Introduction to different types of ceramics

The role of sodium silicate in ceramic production

Sodium silicate is one of the most widely used chemicals in various industries, which has also found a special place in the tile and ceramic industries due to its special properties. This material is used as a strong adhesive, improving the physical and chemical properties of products, and also improving the quality of production in these industries. In this article, we will examine the applications of sodium silicate in the tile and ceramic industries.

Using sodium silicate as an adhesive

One of the main applications of sodium silicate in the tile and ceramic industries is its use as an adhesive. Due to its high adhesion and heat resistance, this material is used as an adhesive between different layers of tiles and ceramics.

Sodium silicate increases the durability and resistance of tiles to environmental factors.

Improving the physical and chemical properties of ceramic tiles

Sodium silicate plays an important role in improving the physical and chemical properties of tiles. Adding this material to the raw materials for ceramic and tile production increases the bending strength, reduces porosity, and increases the hardness of the final products. It also helps reduce the water absorption of tiles, which is very important in the construction industry (1).

3.Increasing quality and improving the production process

The use of sodium silicate in the production process of ceramic and tile helps improve the quality of the final product. Due to its water-repellent properties, this material prevents surface cracks in the tiles and ensures uniformity in the product surface. Sodium silicate also helps reduce drying time and improve the firing process of ceramic and tile.

Application in ceramic and tile glazing

Sodium silicate is used in the ceramic and tile industries as a material in glazing. This material helps create shiny and resistant coatings on the surface of the tile. Also, the use of sodium silicate in glazing increases the resistance of tiles to chemicals and abrasion

CONCLUSION

The results of Figures 1, 2, 3, 4 and Tables show that one of the most important applications of ceramics in the automotive and aircraft industries is protective coatings on the body. In addition, the results of our studies show that tiles and ceramics are important in buildings in the kitchen, building floors, building hygiene and walls. It is also used in the military and computer industries.

Industrial ceramics are a type of ceramics that are designed for special applications and industrial environments. Due to their unique properties, these types of ceramics are used in various industries including automotive, electronics, energy and manufacturing. The outstanding properties of industrial ceramics include high resistance to heat, pressure and abrasion, which makes them suitable for harsh industrial environments. One of the key properties of industrial ceramics is their ability to withstand very high temperatures. These ceramics can withstand temperatures exceeding 1000 degrees Celsius without changing their properties and performance. For this reason, these ceramics are used in industrial furnaces and thermal equipment. In addition to heat resistance, industrial ceramics are also of great interest in the production of electronic components and thermal insulation due to their outstanding insulation properties.

Sodium silicate, as a vital material in the tile and ceramic industries, plays an important role in improving the quality and durability of products. The main applications of this material include high adhesion, improving physical and chemical properties, and increasing production quality. The use of sodium silicate in these industries not only helps improve the production process but also increases the lifespan and resistance of the final products.

The correct and optimal use of sodium silicate in the production of tiles and ceramics can have a direct impact on the quality and durability of the final products and, as a result, lead to the production of products with high added value.

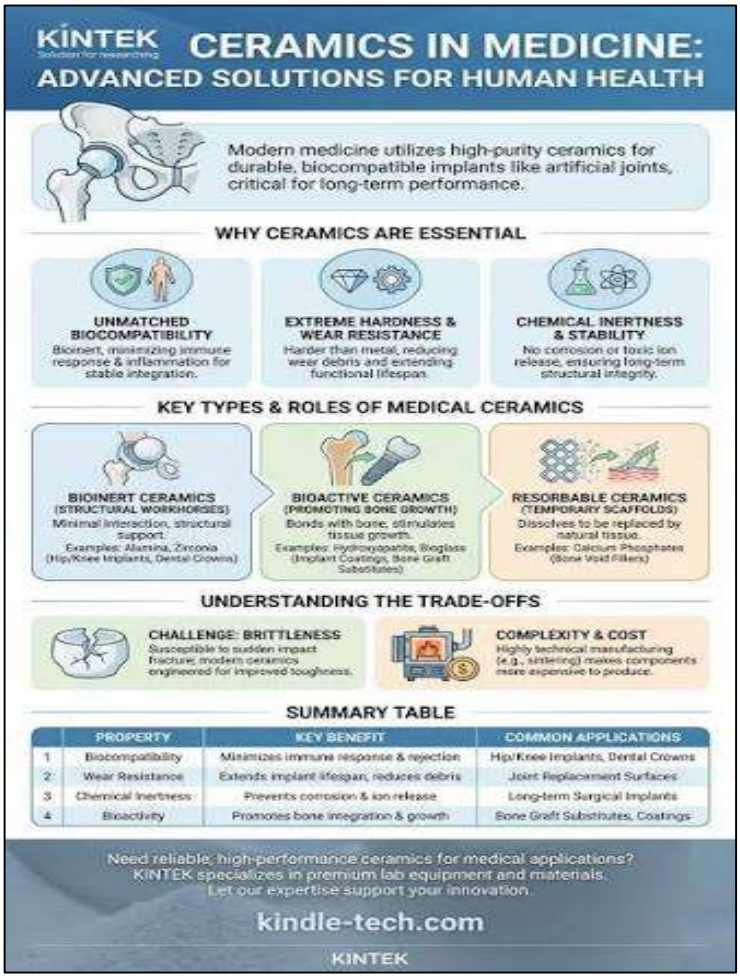


Figure 4: Use of sodium silicate in medicine

The economic role of ceramics in Iran

To export ceramics and tiles from Iran, it is necessary to obtain permits from the Ministry of Industry, Mine and Trade and legal permits for trade. Monitoring standard transportation methods ensures that the cargo is loaded safely and reaches its destination. An important point in the process of exporting tiles and ceramics is that the cargo must have export insurance.

Due to the huge economic developments and the expansion of exports, the special position of non-oil exports in decision-making and its active participation in increasing national production and ultimately per capita income has become more tangible. Due to the lack of an effective model of internal and external factors, the country's exports in the field of tiles and ceramics have not yet been able to find their true position. Therefore, it is necessary to understand the reasons that affect the country's success in exporting and use it to meet the growth and development of the country's foreign trade.

Buyers in the Turkish market are particularly interested in Iranian tiles and ceramics. It is interesting to know that an exhibition is held in Turkey every year and manufacturers of this product can expose all kinds of tiles and ceramics to customers. Given that the culture and taste of the Turkish people are close to the Iranian people, any product that is well received in the country is also in great demand in the Turkish market (2)..

Thanks, and appreciation

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