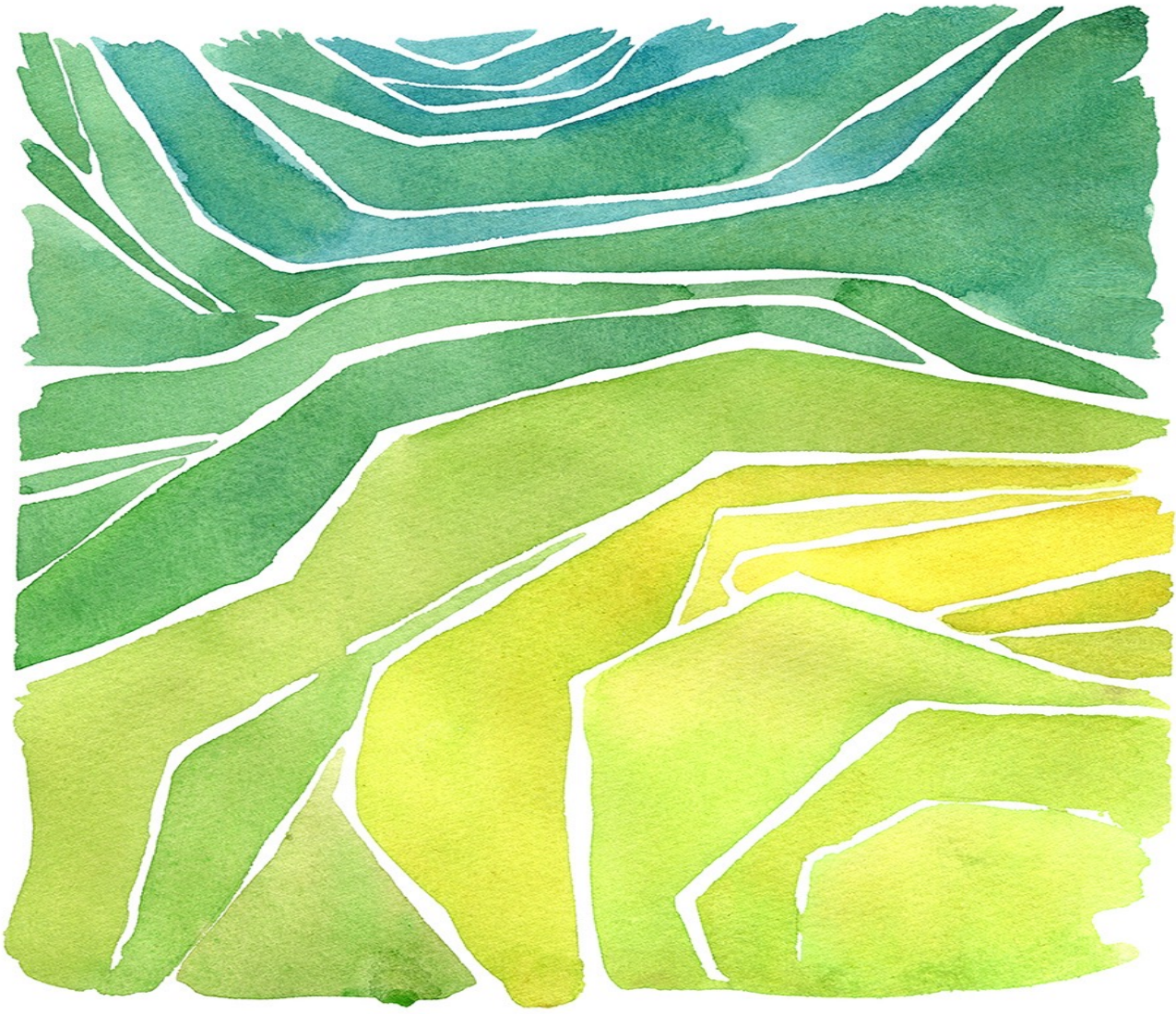
BSB NANOTECH



Biosilico®

Antimicrobial Silica

Technical Overview & Application Guide

Better products. Better prices. Better life.

Biosilico®

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About BSB Nanotech

Biosil is the world's first commercially produced bio-based amorphous silica manufactured with the highest degree of purity and synthesized for a wide range of applications.

Manufactured by BSB Nanotech in Vietnam, this silica is derived from Rice Husk (RH), a common agricultural waste in rice producing countries in Asia. The production of Biosil offers strong environmental, technical and commercial advantages in comparison with conventional methods of producing silica from sand & quartz

The vision of BSB Nanotech is to become a global producer and developer of premium industrial applications of RH-derived Nano Silica.

Key Milestones

- April 2017: Investment License in Saigon Hi-Tech Park
- November 2018: Pilot Plant Completion
- December 2018: First Commercial Order
- February 2018: Nano Lab Completion
- March 2020: Plant Upgrade Completion
- Name change from BSB Development & Investment Co. Ltd to BSB Nanotechnology Joint Stock Company

Senior Management Team

- Hung Nguyen Viet, PhD, Founder & CEO
- Christopher Do, Chief Commercial Officer & Director

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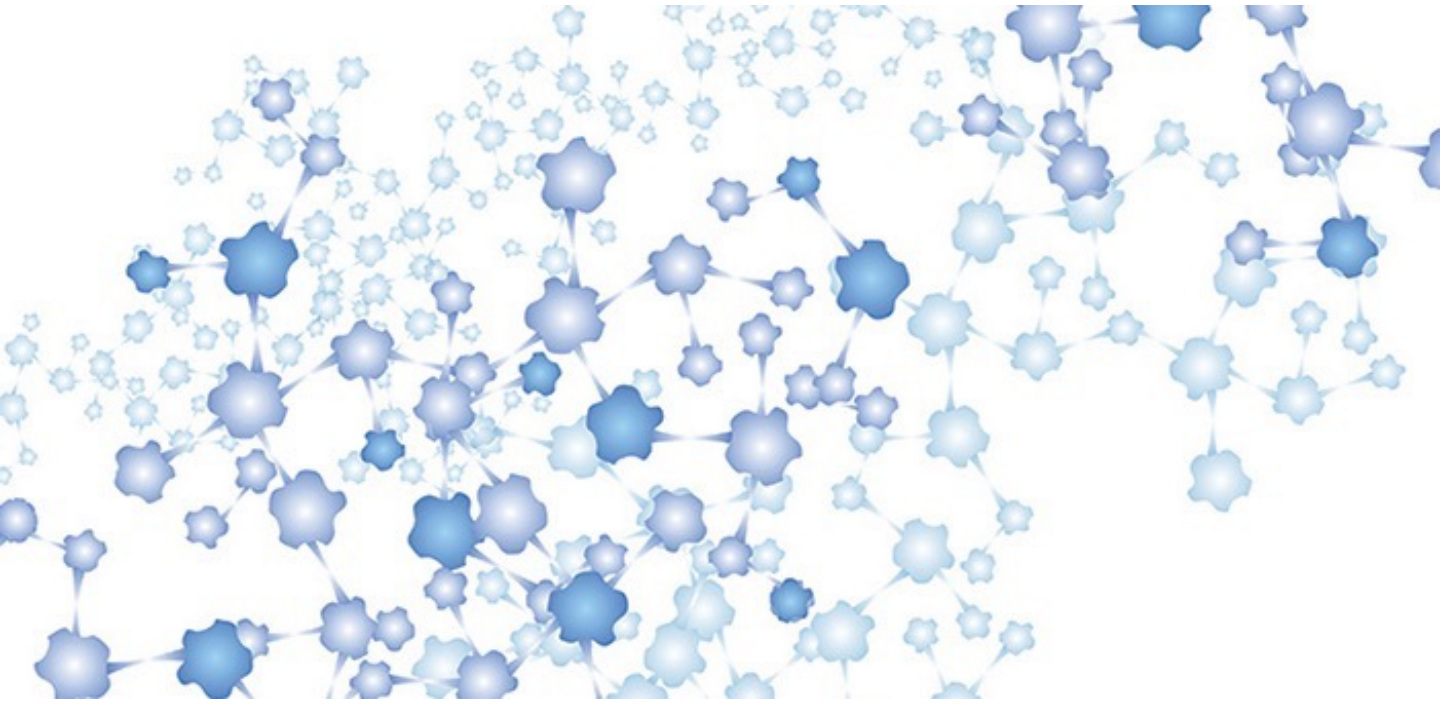

Silica

Natural Occurence of Silica. The two most abundant elements in the earth's crust are oxygen and silicon (46.6% and 27.7% by weight). In nature, silicon is almost always combined with oxygen. Either exclusively in SiO2 or in conjunction with additional elements (as is the case for silicates such as bentonites, montmorillonite, talc, wollastonite. The natural silicates form the basic raw material for key technical products such as cement, glass, porcelain, and bricks.

Basic Manufacturing Process. The silica is usually manufactured by both wet (chemical) and Thermal methods. The wet method yields precipitated/Colloidal Silica and silica gels, whereas the other method yields fumed Silicas, which can be further characterized to yield different grades of silica.

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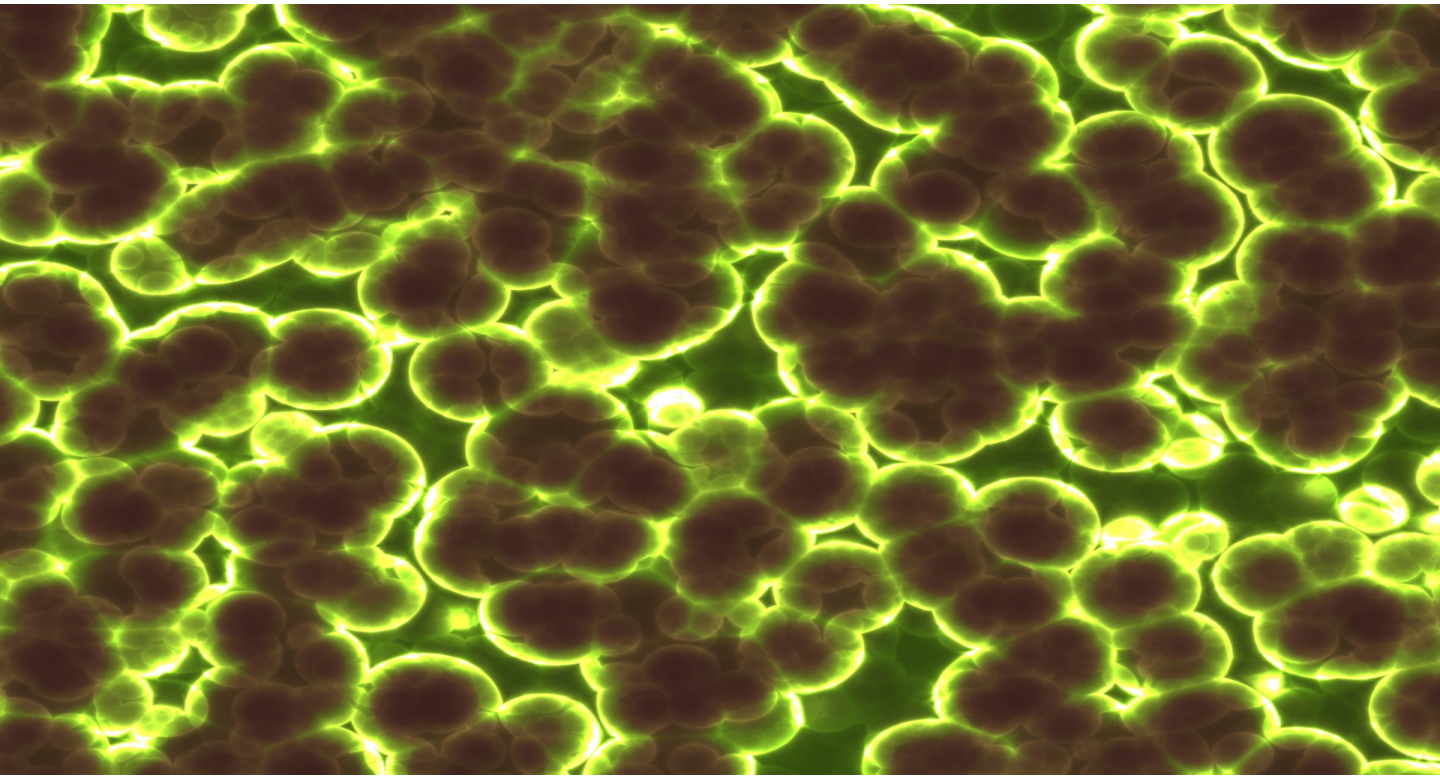
The Bio-Silica Production Pioneer

Asian countries are predominantly rice producers with Vietnam being one of the top five in the world. The extraction of silica from this renewable resource has been endeavored by many scientists and researchers.

Leading this scientific race, BSB Nanotech is the first company to successfully produce rice husk based nanoporous silica on a commercial scale in the world.

Strategically located along the waterways of the Mekong Delta in Vietnam, BSB Nanotech has brought together the abundant access to rice husk, state-of-the-art technologies and skilled professionals to develop a cost effective nanoporous silica in its purest form.

After four years of extensive research, Biosil was formulated to perfection, harnessing the highest amorphous silica content from rice husk and customised for various applications.

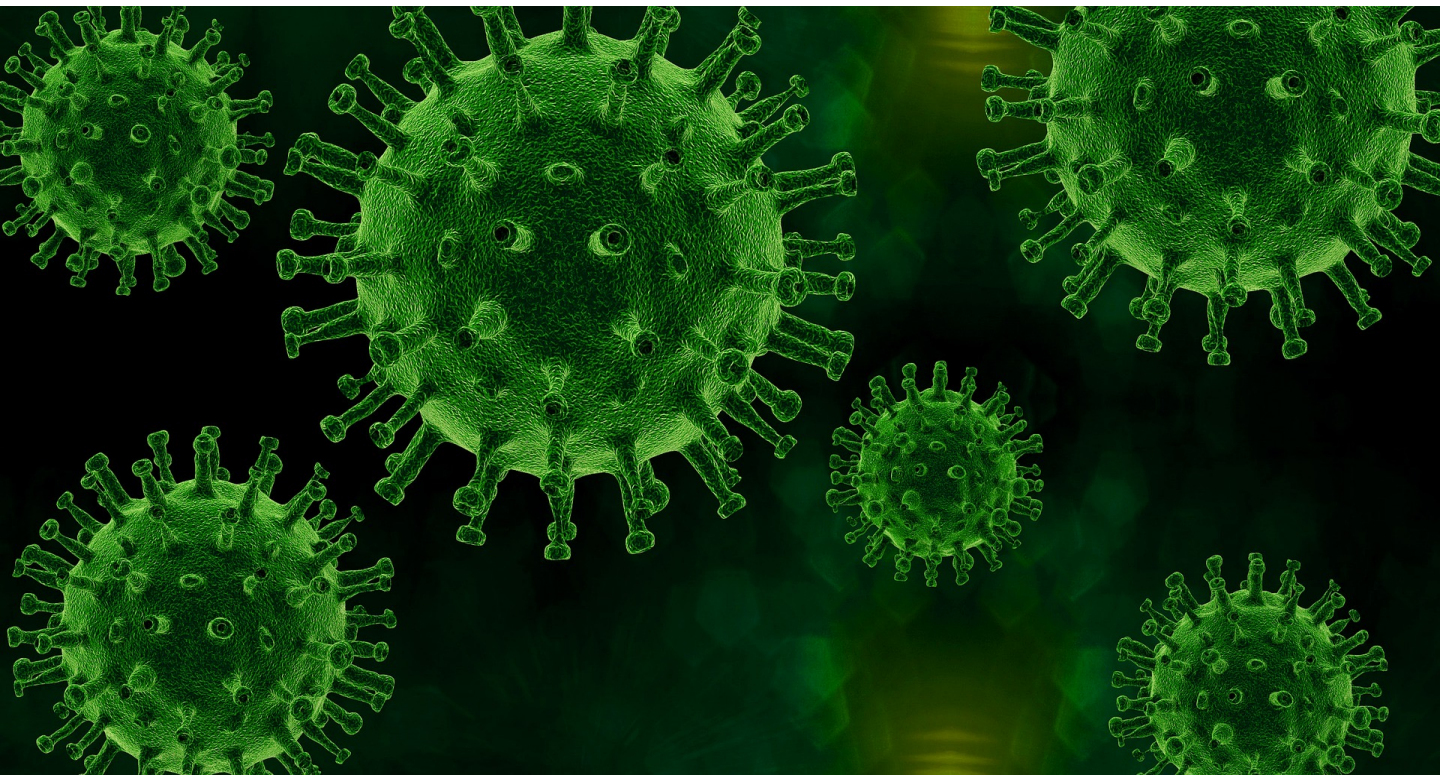


Antimicrobial Silica

Antimicrobial silica is a fine silica powder that is characterized by its ability to inhibit the growth of microbes such as bacteria, viruses and fungi. At the core of our antimicrobial silica products are three types of inorganic additives mainly Silver (Ag), Copper (Cu) and Zinc (Zn). These metals possess inherent antimicrobial activity but exhibit high cytotoxicity toward mammalian cells. Generally, to reduce the cytotoxicity, these inorganic additives are incorporated into inert matrices such as zeolite or glass. Our proprietary chemical reaction, decorates these metals onto silica particles to produce the same effect and has been proven effective for antimicrobial applications. The metals are deposited on the supporting material – silica, so that it is released gradually over a long period of time maintaining its effectiveness. The following section dives into detail of each type of antimicrobial silica and its mechanism.

Ag-SiO_2

Silver-silica nanocomposite is composed of nanosized silver and silica particles. Silver ions, Ag^+ display its antimicrobial properties through three common mechanisms which are binding to DNA, interaction with cell membrane and the interfering of electron transport. It also binds to thiol groups within enzymes and these enzymes and proteins are unable to combat the activity of silver ions, ultimately leading to deactivation. Silver adheres to bacterial membranes, damaging the membrane which compromises the structural integrity as a whole.



Antimicrobial Silica

Cu-SiO_2

Copper-silica nanocomposite is composed of nanosized copper and silica particles. Copper is a heavy metal that exhibits commendable antibacterial, antiviral and antifungal properties. Copper ions, Cu^+ prevent cell respiration whilst also damaging bacterial cell membranes and disrupting viral coats. When inside, copper destroys the DNA and alters the structure of proteins and enzymes rendering them useless or unable to carry out its basic functions. The destructive properties of Cu is further enhanced by bacteria itself, since it releases small amounts of hydrogen peroxide that reacts with Cu^+ to form ferociously reactive oxygen species that attacks and damages the bacteria resulting in internal damage.

Zn-SiO_2

Zinc-silica nanocomposite is composed of nanosized zinc and silica particles. Zinc ions, Zn^+ carry out its antimicrobial activity mainly through four mechanisms which are degradation of cellular envelope, formation of reactive oxygen species (ROS), denaturation of proteins and lastly inhibition of receptor binding. Zinc also disrupts bacterial cellular metabolism and its interaction with proteins and genetic materials results in inability to perform functions such as protein synthesis and genome replication.

Applications

Antimicrobial silica has a vast range of end applications in industrial products such as plastics & packaging, polymers, paints & coatings, textiles, pulp & paper and even medical devices. Products that adopt antimicrobial technology helps prevent growth of unwanted microorganisms whilst keeping products clean, hygienic, odorless, fresh for longer periods or extend its lifetime.

Some of the key applications of Antimicrobial silica covered in this guide includes:

- Plastics & Polymers
- Paints & Coatings
- Textiles
- Medical devices & equipment

No.	Microorganisms	Effectiveness
1	Eschericia coli	√
2	Pseudomonas aeruginosa	√
3	Staphylococcus aureus	√
4	Klebsiella pneumoniae	√

Plastics & Polymers

Integrating antimicrobial technology into plastics or polymers proves to be a game changer across the board because they are found in many industries such as packaging, electronics, automotives, household appliances and so on. There is also high demand for antimicrobial plastic packaging in the food industry which is used to prolong shelf life and reduce food loss or waste. Antimicrobial silica can be incorporated directly into polymers as an additive resulting in inherent antimicrobial properties that are long lasting. The benefits are listed below.

Key benefits:

- Long lasting and ever-present ability to prevent the growth of unwanted microorganisms
- Provides shielding against formation of mold, mildew and fungi on the surface
- Results in clean and odorless products
- Extend the lifetime of treated plastic or polymer products
- Enhances the quality and performance of the plastic or polymer compounds

Recommended dosage:

1-5% depending on the formulation
15-20% for masterbatch formulations

Paints & Coatings

Antimicrobial silica can be directly added as an active ingredient into the manufacturing process of paints and coatings to offer excellent antimicrobial efficacy. The active ingredient provides permanent and lasting protection on coated surfaces against several microorganisms like gram-positive bacteria, gram-negative bacteria, fungi and viruses. Due to the COVID-19 pandemic, greater importance is given recently to the development of antiviral paints.

Key benefits:

- Versatile additive for producing hygienic paints
- Controlled release of biocide over longer periods
- Prevents growth of microbes on substrate
- Reduces transmission of infections
- Maintain aesthetics of coated surfaces by preventing growth of mold / mildew
- Extend the shelf-life of coatings

Recommended dosage:

Typically between 0.5% - 3% on total formulation weight

Textiles

Use of antimicrobial compounds in textiles proves to be a hot topic in recent years with a wide range of applications. Some examples include industrial textiles such as awnings and tents; personal protective equipment; upholstery used in hotels, hospitals and public premises; daily apparel such as garments, socks, underwear and etc. These different type of fabrics are prone to moisture that can lead to growth of microorganisms. Fabric that is impregnated with antimicrobial silica can combat this growth and give rise to the following benefits.

Key benefits:

- Eliminate odor caused by fungi or bacteria
- Provide protection against harmful microorganisms 24/7
- Maintain hygiene of the user
- Inherent antimicrobial activity that is not reduced even after washing or cleaning

Recommended dosage:

Typically between 0.5% - 3% depending on fiber type and incorporation method

Medical devices & equipment

Currently, the pharmaceutical sector is trying to tackle a major issue which is finding a solution for antibiotic-resistant pathogens that are especially found in healthcare facilities like hospitals and clinics. The medical devices sector on the other hand is doing their part to curb the spread of harmful pathogens by introducing antimicrobial technology directly into the manufacture of medical devices or through the use of antimicrobial coatings on the surface. Our antimicrobial silica proves to be a viable and proven option for the medical devices industry as well as medical equipment such as nitrile gloves.

Key benefits:

- Reduce transmission of harmful pathogens through contact
- Diminishes risk of Healthcare Associated Infection (HAI)
- Provides cleanliness and hygiene for equipment used in cleanroom facilities
- Suppress growth of microorganisms whilst also eliminating odor

Recommended dosage:

Typically between 1% - 5% on total formulation weight

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ARE YOU DRIVING CHANGE

OR ARE YOU BEING DRIVEN BY IT

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