

# A natural part of everyday life

Aqueous dispersions  
of colloidal silica



LevaSil

Nouryon

## Nouryon A global specialty chemicals leader

- Produce essential chemicals
- Experts in highly demanding chemistry
- World-class business with strong financial performance, leadership positions, and long-term customer partnerships
- Top-tier performance in safety, sustainability, and reliability
- Leveraging nearly 400 years of experience, our global presence, and our strong company culture to unleash our full potential as an independent company

About **10,000**  
employees  
worldwide

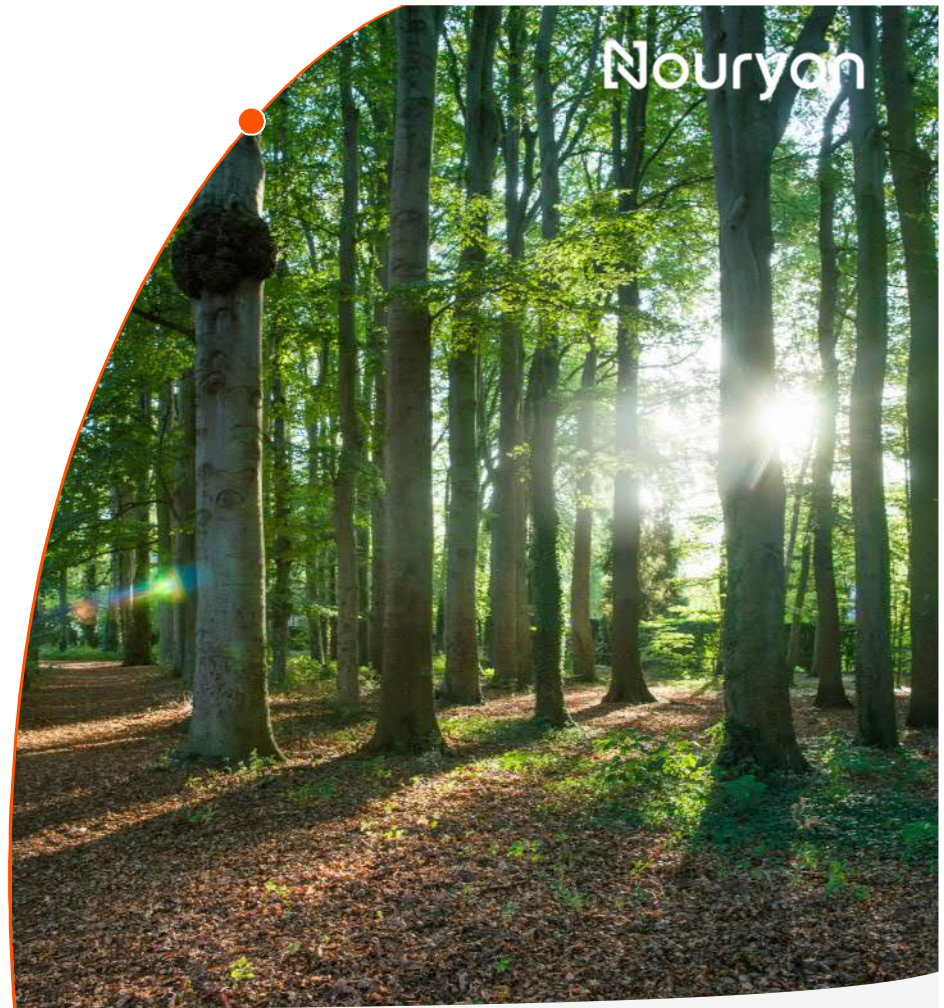
Operating in over  
**80** countries

**€5.0** billion  
revenue in 2017

**80%** of our  
revenue comes  
from #1 or #2  
positions

**Our purpose**

**Your partner  
in essential chemistry  
for a sustainable future**



## A trusted world-leading manufacturer of colloidal silica

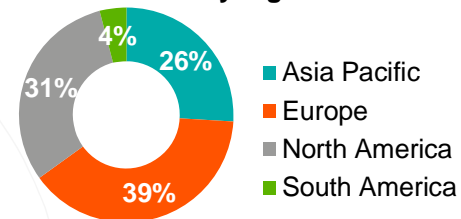
With our global network of manufacturing facilities, we provide our professional partners with a reliable supply of high and consistent quality colloidal silica.

Key success factors for Levasil are:

- Efficient, reliable supply chain
- Product quality and consistency
- Successful innovation and product differentiation
- Strong customer relations
- Increased presence in key markets



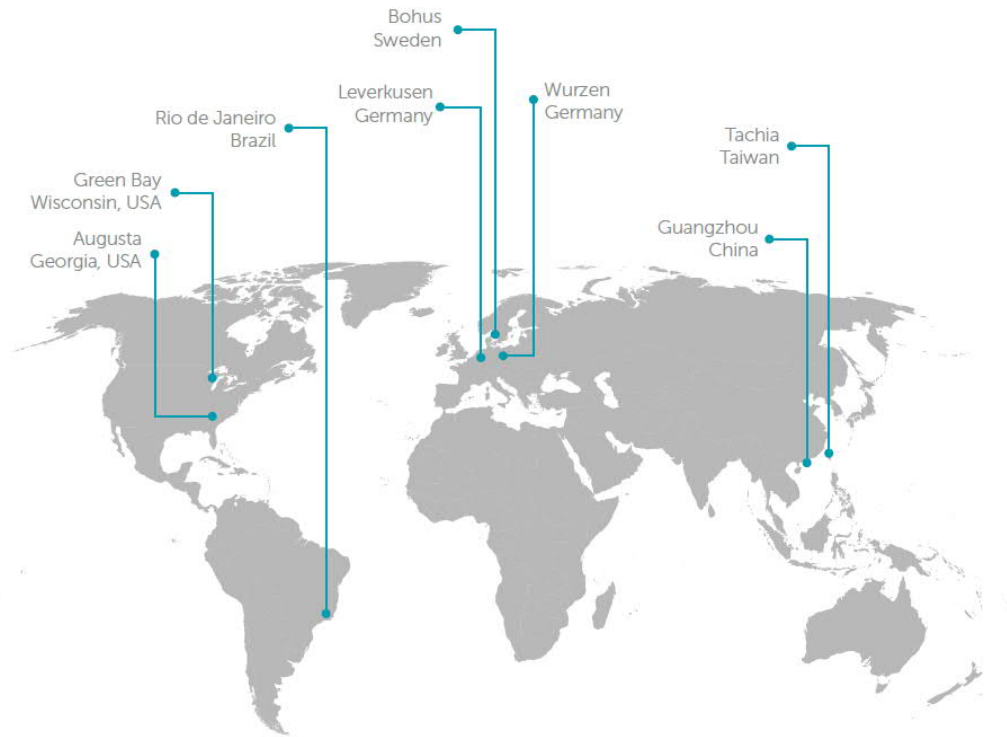
Geo-mix revenue by region in %



● Production site  
● Sales Office

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## Reliable supply with consistent quality



## Our key businesses

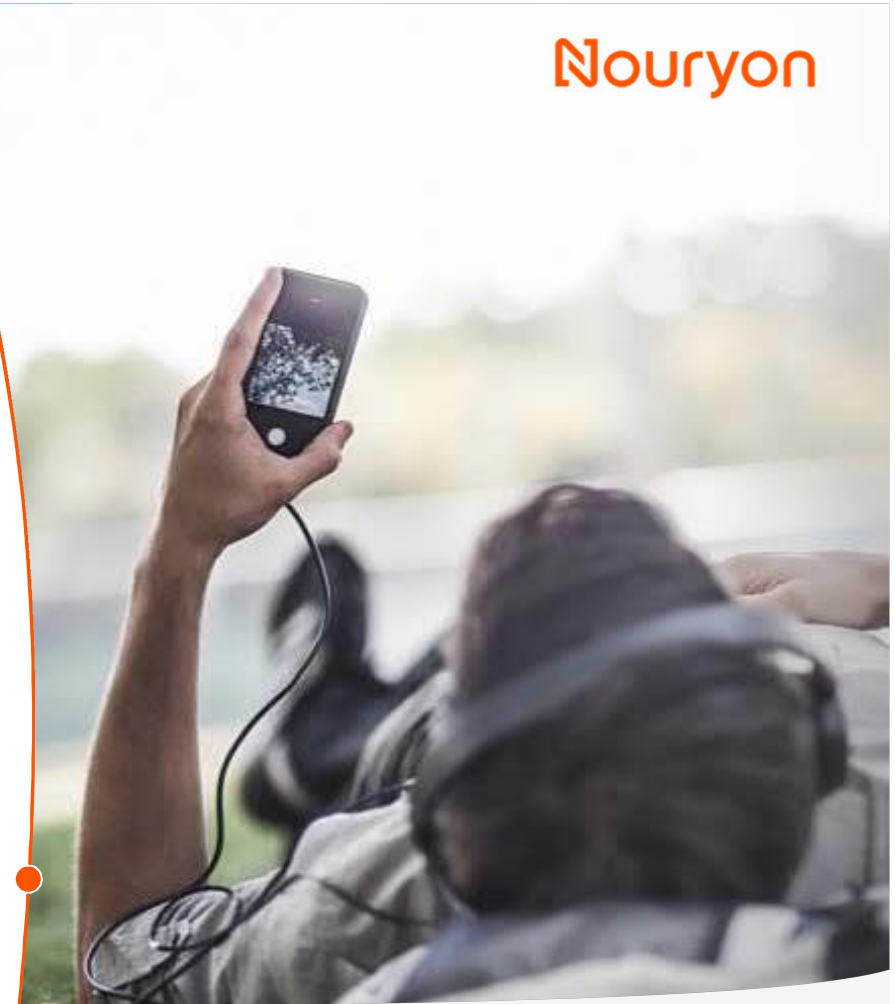
**From the natural ingredients, sand and water, we are constantly developing and delivering versatile and innovative colloidal silica solutions for a multitude of applications and industries.**

Our key business segments are:

- Electronics
- Paper
- Foundry
- Coatings
- Construction
- Catalyst



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# The history of Levasil Colloidal Silica

For sixty years, we have contributed to the success of customers worldwide by improving the key functionality of their applications with breakthrough innovations in silica chemistry and technology.

1970s

Products for Precision Investment Casting (PIC), refractory fiber bonding and anti-skid application are introduced.

1990s

New applications such as polishing for electronics, oil well cementing, battery gelling and beer stabilization are explored. Start of production in Wurzen, Germany and Taichung, Taiwan.

2010s

Growing interest in silane modified colloidal silica for coatings and our Levasil CC product range. Start of production in Guangzhou, China.

2020

By 2020, our goal is that 20% of our revenue will come from products that are more sustainable than our competitors' products. We call it eco-premium solutions.

2000s

Products for coating, cement and ground stabilization are introduced. Start of production in Green Bay, USA and in Rio de Janeiro, Brazil

1980s

Start of production in Bohus, Sweden and in Augusta, USA with focus on paper applications.

1960s

Products for textile treatment, wine clarification and catalyst application are introduced.

1956

The history of our portfolio begins already in the 1930s. The industrial production of colloidal silica starts in 1956 in our plant in Leverkusen, Germany.

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# We create everyday essentials



Precision Investment Casting



Surface polishing



Wood Coatings



Concrete Applications



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Whether you're polishing ultra-flat surfaces for semiconductors or a concrete floor in a warehouse, building large structures or intricate molds; or coating and protecting various surfaces, our Levasil Colloidal Silica products help improve your efficiency, sustainability and end result.



# We create everyday essentials

| Functions                     | Applications  |
|-------------------------------|---|
| Abrasion & Scratch Resistance | Coatings  |
| Adhesion                      | Adhesives, coatings, sealants   |
| Anti-blocking                 | Coatings, plastic films, textiles   |
| Anti-soiling                  | Coatings, cleaners, textiles  |
| Binding                       | Precision Investment Casting (PIC), refractory materials, coatings, catalyst, well cementing, plastic films |
| Dispersing                    | Pigments, inks, resins  |
| Flocculation                  | Beverage, water treatment, refractory materials   |
| Frictionizing                 | Paper, plastic films, textiles  |
| Gelling                       | Batteries, ground consolidation   |
| Polishing & Planing           | Semiconductor materials, sapphire, glass and metal, optical lenses, cement and stone polishing              |
| Printability                  | Paper, plastic films, inkjet and photo  |
| Strength & Stability          | Concrete, well cementing  |



# Key applications

## Coatings

Our products enhance the performance of coatings by delivering anti-soiling properties, improving hardness, enhancing pigment dispersion and prolonging open time.

### Applications

Decorative coatings, Inorganic & insulation coatings, Non-Stick coatings, Protective coatings and Wood coatings

## Surface Polishing

Our products are used as a "hi-tech" abrasive for shaping, smoothing, and polishing silicon, metals, sapphire, and other precision substrate materials

## Construction

Used across the construction industry our products increase durability and strength in cementing operations and ground consolidation.

### Applications

Concrete  
Ground consolidation

## Foundry

Thanks to their capacity for greater intricacy of casting design and high temperature tolerance, our products are used as a binder in precision investment casting of ceramic shells. This also makes them very useful in refractory fiber bonding and ceramics casting applications.

### Applications

Precision Investment Casting and Refractory Materials

## Oil Field Services

Well cementing applications benefit from using our products. Thanks to a mix that improves strength and shortens setting times, well drilling activities usually can resume more quickly – saving time and money. Additionally, the low specific gravity of colloidal silica produces lightweight slurries that can be injected more controllably.

## Catalyst

Our silica is an ideal component in catalyst manufacturing thanks to its consistent, controlled surface area, particle size and high purity. Its excellent inorganic high temperature binding capability increases the mechanical stability of catalysts.

## Key applications

### Ahesives

Used in waterborne adhesive formulations, colloidal silica can significantly increase the thermal stability and mechanical strength of bonded joints. Additionally, colloidal silica can help adjust viscosity, as well as shorten the drying time of film-forming organic dispersions.

### Beverage

In beverage clarification applications, our products are used as a functional processing aid for removing undesirable components from liquids.

### Cleaning

Colloidal silica dispersions can improve the efficiency of cleaning detergent formulations. When cleaning with detergent formulations enhanced by colloidal silica, surfaces receive improved anti-soiling properties and glass and mirrors substrates are less likely to exhibit fogging.

### Gel & AGM Batteries

Colloidal silica is an extremely cost-efficient, easy-to-use, and environmentally sound option for gelling sulfuric acid to obtain a solid electrolyte (gel cell) in valve-regulated, lead-acid (VRLA) batteries and for reducing the acid stratification in absorbed glass mat (AGM) batteries.

### Textile

Alone or in combination with other additives, colloidal silica can help stabilize weave structure and improve seam slippage, as well as improve the dry hand and control fabric sheen.

### Water Treatment

Our products are useful in water treatment applications to improve the dewatering efficiency of solids and enhance the removal of organic substances.

## Key applications

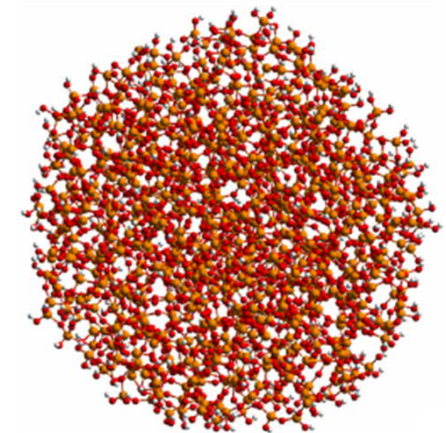
### More applications

Levasil Colloidal Silica can be used in numerous applications and it enhances functionality in an ever growing number of products. Other areas of use are for example:

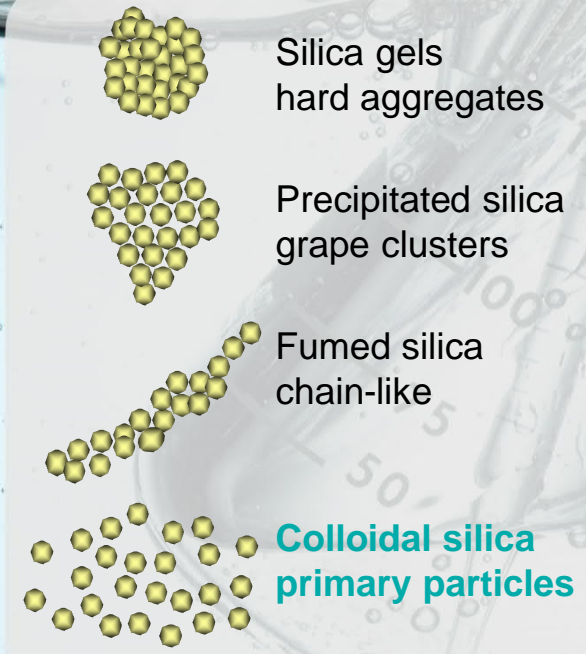
- Paper – retention and antiskid
- Pigment & Fillers
- Plastic Films

## What is Colloidal Silica?

- Very small particles of amorphous silicon dioxide ( $\text{SiO}_2$ ), dispersed in water
- Safe for both humans and the environment
- Large surface area, due to the numerous small particles
- The particles are usually electrically charged, why they can easily interact with one another or to other substances
  
- The properties of colloidal silica dispersions can be varied in many ways:
  - Concentration: 7– 50% silicon dioxide
  - Particle size distribution
  - Structure: Discrete particles (high S-value) or chains (low S-value)
  - Particle diameter: 2–100 nm
  - Surface area: 30-1100 m<sup>2</sup>/g
  - pH: 2–12
  - Modifications: ammonium, aluminate, chloride, silane, deionized



# Types and Characteristics of Silica



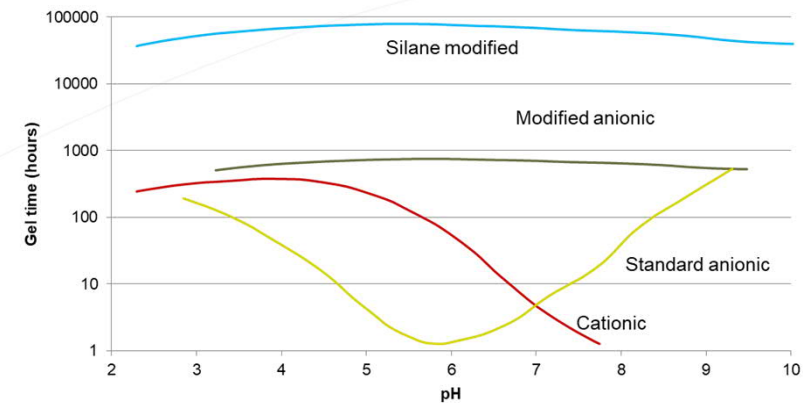
| Type                     | Density g/cm <sup>3</sup> | Aggregate Size μm | Primary Particle nm | Surface Area m <sup>2</sup> /g | Appearance |
|--------------------------|---------------------------|-------------------|---------------------|--------------------------------|------------|
| Silica gels              | 0.16                      | 2-20              | 2-100               | 100-800                        | Dry powder |
| Precipitated silica      | 0.16                      | 1-5               | 20-50               | 20-100                         | Dry powder |
| Fumed (pyrogenic) silica | 0.04                      | 1                 | 10-20               | 100-400                        | Dry powder |
| Colloidal silica         | 1.15                      | n.a.              | 3-150               | 50-1200                        | Liquid     |

## Facts and figures

### Parameters controllable to tailor the product for specific applications

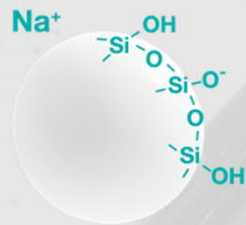
- Particle size and particle size distribution
- Surface Charge & Charge Density
- pH
- Surface Area
- SiO<sub>2</sub> Solid Concentration
- Counter ion
- Surface Modifications
- Level of structure and aggregation

### Effect of pH to Colloidal Silica



All our products are dispersed in water

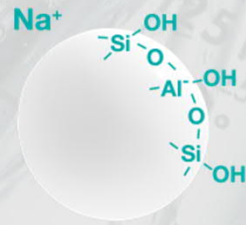
Levasil Product categories



$\text{NH}_4^+$

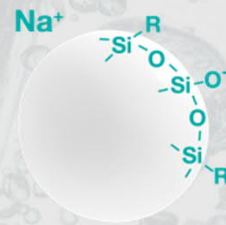
Anionic particles  
Sodium or ammonia  
stabilized

**pH 8-11**



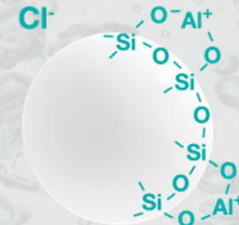
Anionic particles  
Aluminate modified

**pH 5-11**



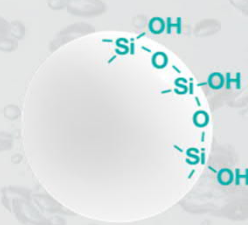
Anionic particles  
Silane modified

**pH 7-9**



Cationic particles  
Chloride stabilized

**pH 2-5**



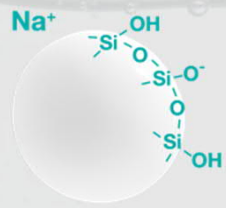
Non-charged particles  
Deionized modified  
Electrolyte free

**pH 2-4**



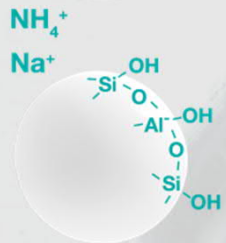
# Levasil Product categories

## Anionic particles



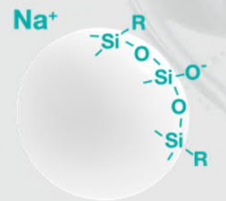
### Sodium stabilized

|                        |             |
|------------------------|-------------|
| % SiO <sub>2</sub>     | 15-50       |
| pH                     | 9-11        |
| SA (m <sup>2</sup> /g) | 35-750      |
| PSD                    | narrow-wide |



### Aluminate modified

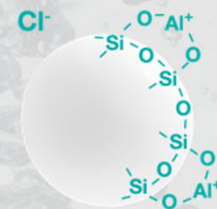
|                        |          |
|------------------------|----------|
| % SiO <sub>2</sub>     | 7-40     |
| pH                     | 8.5-10.5 |
| SA (m <sup>2</sup> /g) | 165-1100 |
| PSD                    | narrow   |



### Silane modified

|                    |        |
|--------------------|--------|
| % SiO <sub>2</sub> | 15-40  |
| pH                 | 8-11   |
| Particle size (nm) | 5-12   |
| PSD                | narrow |

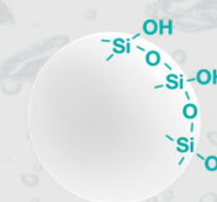
## Cationic particles



### Chloride stabilized

|                        |             |
|------------------------|-------------|
| % SiO <sub>2</sub>     | 25-45       |
| pH                     | 3.8-4       |
| SA (m <sup>2</sup> /g) | 85-160      |
| PSD                    | narrow-wide |

## Non-charged particles

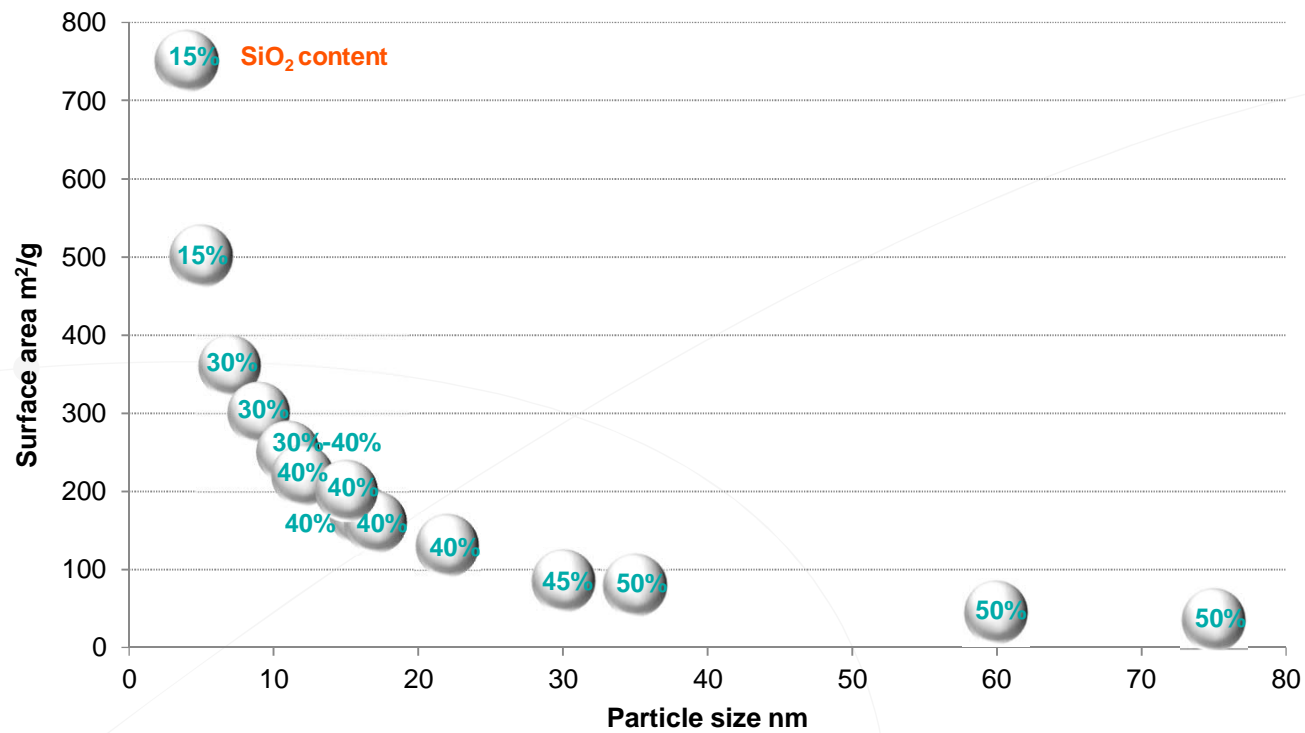


### Deionized

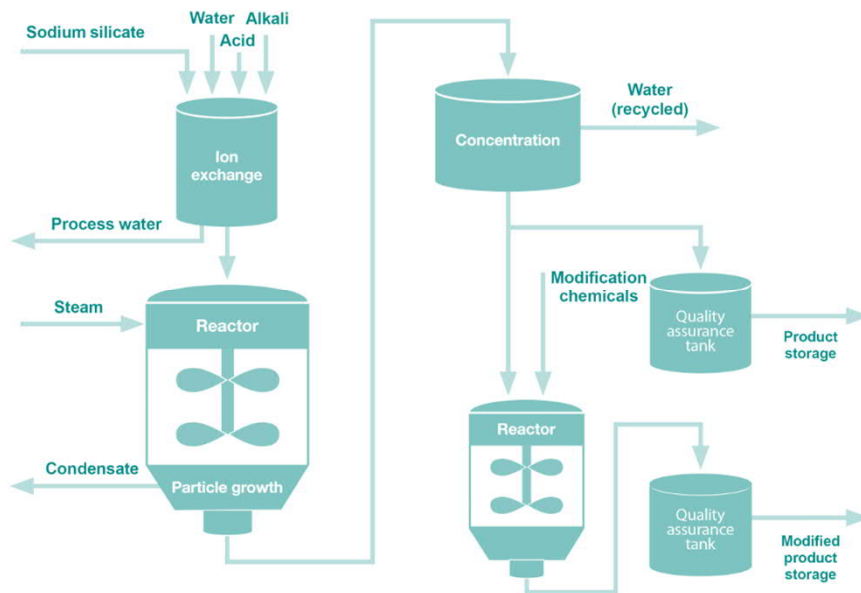
|                        |         |
|------------------------|---------|
| % SiO <sub>2</sub>     | 20-40   |
| pH                     | 2.4-2.8 |
| SA (m <sup>2</sup> /g) | 80-300  |
| PSD                    | narrow  |

# Wide portfolio of anionic particles

Surface area m<sup>2</sup>/g vs. particle size nm



# Process overview



A photograph of a woman in profile, looking down at her smartphone. She is sitting at an outdoor cafe table. In the background, another person is visible, and the scene is set in an urban environment with buildings and a street. The image is partially obscured by a white curved shape at the bottom right.

# Thank you for listening

Visit us at [colloidalsilica.nouryon.com](http://colloidalsilica.nouryon.com)

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