Silica Pigments for Print Media & Paper

SYLOJET® Micronized and Sub-micronized Silica
SYLOID® Micronized Silica
LUDOX® Colloidal Silica
SYLOWHITE™ Aluminium Silicate
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REACH
Global Scope

Product Range
SYLOJET®
Pigments for Ink-Jet Coatings
SYLOID®
Matting Agents for Coatings
LUDOX®
Colloidal Silica
SYLOWHITE™
Titanium Dioxide Extenders for Paints and Printing Inks
DURAFILL®
Special Pigments and Fillers for the Paper and Pulp Industry
TRISYL®
Silica Gel for Refining Edible Oil and Renewable Diesel
DARACLAR®
Beer Stabilizers
CRYOSIV®
Desiccant for Refrigerant Drying
PHONOSORB®
Beaded Adsorbents for Insulating Glass
SYLOBEAD®
Process Adsorbents
SAFETYSORB®
Desiccants for the Pharmaceutical and Diagnostic Applications
DARACLAR®
Beer Stabilizers
SYLOBLANC®/SYLODENT®
Abrasive and Thickening Agents for Toothpaste Industry
SHIELDEX®
Non-toxic Anti-corrosion Pigments
PERKASIL®
Reinforcing Agents for the Tire and Rubber Industry
APPERTA®
Can Coatings
DAREX®
Can and Closure Sealants
SISTIAGA®
Can Coatings
CELOX®
Oxygen Scavengers
SINCERA®
Closure Sealants

European Headquarters Worms, Germany
The Company

Grace Davison is a business division of W.R. Grace & Co., one of the world’s largest companies for specialty chemicals, materials and formulation technologies.

Grace Davison produces a wide range of products – synthetic amorphous silica gel, colloidal silica, zeolitic adsorbents, precipitated silica and silica-aluminas, materials for chromatography, sealants, closures and coatings for the packaging industry, polyolefin and refinery catalysts.

These specialty chemicals and products improve product performance or enhance manufacturing processes within a wide range of industrial applications. Our key strengths lie in the development of innovative technologies through which product quality and application characteristics are improved. Manufacturing flexibility, global infrastructure and the commitment of our company to close customer relationships are factors which provide high levels of customer satisfaction.

With manufacturing sites, research & development centers and sales offices around the globe, we are well prepared to meet the challenges of global market requirements. With our sales offices in all key countries, we are able to quickly react to the needs of our customers. In order to guarantee a constantly high level of product quality, all Grace sites are ISO certified and carry out Quality Management Systems.

Products which are tailored to the needs of the customer, punctual deliveries, specialist technical support at a high level and a reliable customer service department are all factors that go to make Grace a preferred supplier within the industry.

Silica Solutions for the Printing Industry

Grace® silica products have been used successfully for many years as performance enhancing additives for diverse print media and paper coating applications. The silica material properties meet today’s requirements for highly sophisticated ink receptive coatings and ink-jet related applications. The high internal porosity, surface structure and a low refractive index make silicas the first choice among available pigment types.

Product families are specialized with regard to glossy, semi-gloss and matt coatings on porous substrates and non-porous films. Grace® silicas provide excellent properties for all ink-jet related technologies, ranging from water-based paper coating, coatings for art and photo printing to industrial applications with solvent-based inks.

Our unique SYLOJET® submicron silica technology enables improved printability for the rapidly evolving new fast ink-jet in-line coating application. Grace® silicas also offer optimal performance in thermal printing technologies as well as in offset and flexographic media.

For many years, Grace Davison has been dedicated to working on innovative amorphous silica solutions to meet the needs of the Paper & Print Media Industry. Our global product portfolio, coupled with our know-how and global presence, allows our customers to meet the global and local challenges of the Paper & Print Media Industry.

Safety First

Our first priority is to ensure the safety of all those who work with us or come into contact with our products. Safety data sheets and information concerning the way in which Grace’s products adhere to application-related provisions are available on request.

At Grace Davison, the environment is a major issue and we are proud to maintain an outstanding record of leadership in safety standards and good corporate citizenship.

Through the Responsible Care® Program, every Grace Davison facility worldwide fulfills both stringent health and safety requirements as well as environmental requirements. It demonstrates the high priority of work safety within the organization, which has led to a substantial reduction in workplace injuries, bringing the company close to the goal of zero.

Manufacturing Plant Curtis Bay, Maryland, USA
The Products

SYLOID® / SYLOJET® Micronized Porous Silica are used in a wide variety of ink-jet and print applications. The unique structure of microporous silica provides ideal properties for high ink absorption. Unlike most conventional pigments in the paper industry, porous silica particles have a sponge-like rigid silica structure. Its internal pores provide additional void volume for liquid absorption into the bulk. In ink-jet the large surface area, with abundant reactive sites for dye molecules, provides perfect conditions for bright, saturated colors and wide color gamut. The low refractive index of the silica material facilitates dye molecules in lower layers of the coating to contribute to the color density.

Key advantages of SYLOID® Micronized Silica
- Outstanding ink absorption capacity controls dot size, resolution and bleeding
- Low refractive index providing brilliant colors
- Defined pore structure allowing for a controlled ink uptake dynamics.

The SYLOID® / SYLOJET® silica products provide the highest absorption capacity of all silica grades, with a pore volume of 1.6 to 2.0 ml/g depending on specific grades. These grades work best in coating formulations with high binder/pigment ratios. SYLOID® silica grades with a pore volume of 1.2 ml/g are designed to work with lower binder/pigment ratios and achieve higher solid levels in liquid dispersions.

SYLOID® Micronized Porous Silica Hydrogels
SYLOID® silica W-grades are unique in their low dusting tendency. Their internal silica pores already contain water, which allows rapid incorporation into aqueous formulations. Like all other micronized porous silica grades, SYLOID® silica W-grades are supplied in powder form.

SYLOJET® Submicron Porous Silica A- and C-Grades
The SYLOJET® silica A- and C-grades are submicron porous silica grades with particle sizes below 1 micron. They can be used for numerous ink-jet applications – from matt to glossy, for inks and ink-jet related areas. They are suitable for various kinds of functional layers with low coat weight and need less binder than the micronized silica grades. These grades are supplied as aqueous dispersions, allowing easy dosing and incorporation into aqueous systems.

Key advantages of SYLOJET® Submicron Silica
- Avoiding handling of dusty powders
- Available in cationic and anionic versions providing easy compatibility
- Particles below one micron to allow smooth and semi-glossy coatings

LUDOX® Nano-Silica Dispersions and Colloidal Silica provide unique properties for ink-jet top coats and receiver layers. The particles in LUDOX® colloidal silica are discrete spheres of silica with no porosity. The absence of particle porosity make it suitable for achieving surface modifications and other functions rather than to provide ink-capacity.

Key advantages of LUDOX® Colloidal Silica
- High gloss level in cast-coated ink-jet
- Excellent transparency
- Improved marking resistance

A wide range of particle sizes and modifications is available to provide compatibility and colloidal stability in the different applications.

Additives
High quality ink-jet prints require precise adjustment of the interaction between ink receptive coating and printing ink, controlling both the tendency of ink to spread on the coating surface and the velocity of ink penetration into the coating layer.

SYLOJET® A200 aluminum salt solution contains an acidic cationic aluminum salt, which is an effective agent to adjust the coating surface charge and thus improve ink compatibility.

SYLOWHITE™ Aluminium Silicate
SYLOWHITE™ SM405 silicate is a fine-sized precipitated sodium magnesium aluminium silicate powder that is used as a specialty coating pigment for paper. It can give benefits for solvent ink-jet, offset and flexographic ink applications due to its internal porosity which provides liquid adsorption capacity. SYLOWHITE™ aluminium silicate has a higher opacity compared to silica gel, thereby improving paper whiteness. It can also be used as a titanium dioxide extender.
Ink-Jet Printing – Formulation and Material Grade Selection

Silica Properties and Aspects of Use
The porous structure, combined with a high surface area, and the optical properties make the silica materials the first choice for matt ink-receptive coatings. The selection of a specific grade is mainly based on the pigment pore volume and particle size, and other secondary properties such as the specific surface area and the pore size distribution.

Main Benefits of Silica Pigments
Silica pigments are different from other materials like calcium carbonate pigments or clays because Silicas have a combination of
- porosity
- high surface area
- low refractive index

Silica Coating Recipes
The surface properties allow the use of silica pigments in water based as well as in coatings with organic solvents, whereby the water based formulas dominate. For more details please see page 8 “Material Handling and Dispersion”. The function of the silica coating is to adsorb the ink-liquid.

Ink-Compatibility
The silica as such is compatible with basically all types of inks: water-based, solvent, eco-solvent and UV inks, dye based and pigmented inks. The different inks require tailored coating formulations for optimal print results. The high surface area of silica pigments allow their use as a substrate for a mainly monolayer adsorption of the printed dye colorants thereby providing brilliant colors and high optical densities.

Cationic Recipes
For the purpose of dye fixation, most of the ink-receptive coatings have a cationic charge. It is very easy to create a cationic silica surface, simply by dispersing the silica powder into the water after the desired cationic fixative has been added. The silica surface is compatible with all types of cationic surface modifiers such as polydadmac, polyamine or alumina salts. For each recipe, there is a narrow optimal pH range, often between 3.5 and 4.

Binders
The selection of suitable binders is important to provide two main functions: a) binding the silica particles without plugging too many of the pores, b) modifying the surface energy to a desired level; not completely hydrophilic but at the same time not too hydrophobic.

Silica Grade Selection for Matt Ink-Jet
SYLOID® / SYLOJET® Micronized Silica Products are the main choice for premium matt ink-jet media: papers, films, various fabrics, canvas and more.

The following scheme provides an overview how to select the silica best suited to the desired application and print quality requirements. This refers mainly to matt coatings.

<table>
<thead>
<tr>
<th>Pigment Pore Volume</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYLOID® 72/621 Silica</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYLOID® C800 Silica</td>
<td></td>
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</tr>
</tbody>
</table>

Dispersion Solids

Binder Demand (binder/pigment ratio)

Required Coating Thickness

Print Quality (color & resolution)

SYLOJET® Submicron Silica Products can be used as a lower layer for photo glossy ink-jet. The unique nature of the particles make them also suitable for light paper machine in-line coatings.

LUDOX® Colloidal Silica Grades create gloss and contribute to the image forming in the top coat of cast coated glossy ink-jet papers for water based dye inks. Micro-cracks overcome the low porosity of the colloidal silicas in such coatings, since uncracked coatings from the non-porous colloidal particles often have too low ink absorption. The unique properties of colloidal silicas can also provide specific functions such as improving the surface strength in a light top coat layer over a microporous alumina receiver layer.

For an overview of available grades, please refer to the separate leaflet “Print Media Solutions”.

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**Ink-Jet Printing – Applications**

**Traditional Ink-Jet Media**
We find different types of silica pigments in all kinds of ink-jet media – papers for small and large format, various film media, photo ink-jet on PE paper, on clear film for back-lit, release films for textile transfer printing, labels and more. The selection of a suitable silica depends on the technology: printer types, inks and media.

The main application for porous silica is for water based, dye and pigmented inks in microporous coatings. For solvent and eco-solvent inks similar microporous formulas are also in use for film coatings. There are also films with lighter polymer type coating where silica is added only as a “spacer” or anti-block agent to reduce ink transfer in a back side contact. UV ink-jet printing typically doesn’t require a porous coating.

**Fast Ink-Jet or Industrial Ink-Jet**

In this fast growing market, the paper economics are very important. Whereas lower quality papers are made without a surface coating or only pigmentation, high quality media have a silica coating on both sides. Grace’s unique SYLOJET® submicron silica grades offer the option for light paper machine in-line coatings to enhance printability, and thus achieve improved colour quality at a favorable cost.

**Main Benefits offered in Ink-jet Printing by SYLOID®/SYLOJET® Silicas**
- Controlled silica pore size to ensure high speed ink absorption
- Very good resolution, no bleeding
- Combined with highest optical densities

**Semi Glossy Brochure Ink-Jet**

PCC / Silica mixes in a lower layer coating on paper plus a lighter microporous glossy top coat, for example based on suitable alumina pigments, can provide an economic structure for coated semi glossy ink-jet papers.

**Comparison SEM picture of the uncoated base layer**

**SEM picture with a light coating of submicron silica**

**To reduce the coating cost it is possible to mix silica pigments with calcium carbonate. It is important then to adjust application parameters accordingly.**
Digital Printing – Toner and Thermal Technologies

Light coatings with porous silica pigments can create specific structures on a substrate, especially on various film types. Such a specific surface structure improves the keying of toner particles or in case of thermal transfer, the fixation of the colored wax from the donor ribbon. The layer thickness ranges from 1 to 3 µm or more. Typically, finer silica grades are selected for such applications. In the case of water based coatings, the Grace submicron silica, SYLOJET® A and C dispersions are the first choice for a slightly structured surface.

For a rougher surface, especially when increased adsorption capacity is required, a low particle size micronized silica like SYLOID® 244 silica or SYLOID® C803 silica would be suitable.

In the thin top-coat of thermal papers, the submicron silica can provide some porosity which improves the printability with offset and flexographic technology. At the same time, the silica particles are quite transparent compared to standard pigments. This means there is only very little covering effect of the black which will develop in the underlying thermal layer in the subsequent thermal printing process. Submicron silicas added in the thermal layer can improve specific properties for higher value grades.

Main Benefits in Thermal Paper
- Excellent top coat printability
- Superior print resolution in the thermal layer

Analogue Printing – Offset and Flexographic Media

Main Benefits in Offset Printing offered by Grace Silicas
- Reduced ink setting time
- Faster processing of printed paper
- Lower gloss level and reduced marking sensitivity of matt coated papers

Silica can be mixed with standard pigments; 10 parts of silica are often enough to achieve the targets. Relatively thin layers on film – 3 to 6 g/m² silica coating – can improve the printability to an extend that the film is printable like a coated paper.

For flexographic printing papers, SYLOID® / SYLOJET® silica can improve the printability, especially for inks with reduced solvent levels. The increased porosity results in faster ink absorption and reduces the risk of residual ink-transfer into the subsequent inking unit. In this application it is sufficient to mix a certain ratio of porous silica pigment with the standard coating pigments, to improve the ink-setting substantially.

Paper Coatings based on Calcium Carbonate Silica Mixes

SEM-Coating cross section
Element Mapping Ca
Element Mapping Si
Material Handling and Dispersion

Silica Powders
Depending on the porosity and particle size, the micronized silica materials are light powders with apparent particle densities down to 0.4 cm³/g and with bulk densities from 0.5 to 0.07 g/cm³. Grace provides advice for powder handling and dispersing technology if requested.

Aqueous Silica Dispersions
Porous silica pigments show some specific characteristics when dispersed in water. The viscosity development of silica dispersions in water is strongly pH dependent. The effect becomes noticeable when the silica concentration is close to the maximum possible silica loading – high occupied volume ratios:

The occupied volume theory describes the silica loading in a dispersion. For more details, refer to the Grace technical bulletin, “Silica Pigments in Water Based Coatings”.

Preferable pH ranges for silica dispersion in water are:
- Below pH 4.5, also cationic
- Above pH 9
- In the neutral range only with sodium aluminate as dispersing agent

Standard dispersing agents like polyphosphates or acrylates have no effect on silica.

LUDOX® Colloidal Silicas
For the optimal usage of LUDOX® colloidal silicas, the compatibility and stability in the various application situations needs to be considered: pH, concentration, nature of other ingredients in a formula. Additional support is available from Grace Technical Customer Service.
Test Capabilities

Raw material characterization
- Particle size distribution
- Porosity, specific pore volume
- Surface area

Media Characterization
- Media structure by means of SEM and elemental mapping (EDX)
- Gloss measurement
- Whiteness, L a b
- Surface energy as dynamic contact angle
- Layer porosity by mercury intrusion

Dispersion Solutions
- Viscosity: Brookfield, Bohlin
- Surface tension

Print Evaluation
- Ink-Jet printing on desk-jet and photo printers
- Optical densities
- Color gamut
- Image analysis – “QEA/Personal IAS” instrument

Application Services
Hand sheet coating with starting formulas for ink-jet on different substrates. Dispersing trials, rheological characterization, evaluations of binders, cationic additives and more. Coating trials to compare pigments for layer porosity, printability and other parameter.
Innovation and Quality

Research & Development
Technical Customer Service
Grace Davison is a firm believer in driving innovation. Our researchers are continuously working to improve the quality of existing products and seeking ways to broaden our product range in order to fulfill the increasing requirements of our customers. With principal R&D centers in Columbia, MD/USA and Worms/Germany, Grace has over 80 years of experience and expertise in the development of silicas for numerous industries. Modern laboratory facilities enable us to carry out a range of chemical/physical characterization experiments, and we are able to carry out application testing in our technical center.

Our experienced technical personnel with a paper and coating industry background is able to provide expert professional advice to our customers regarding the most effective use of Grace Davison products for ink-jet coating applications.

Grace Davison’s Global Technical Customer Service (TCS) group is dedicated to developing and supporting worldwide technical partnerships with our customers in the digital media industry.

The group consists of experienced paper and coatings professionals whose primary objective is to ensure customer satisfaction regarding application and product performance related issues. Working closely with our global sales organization, the TCS group strives to exceed customer expectations.

The main support activities are:

- Customer consultations through customer site visits, video-conferencing and other forms of telecommunication.
- TCS projects which involve the application development laboratories of Grace Davison. General projects to develop concepts based on Grace materials for different print media, find novel solutions and allow the most suitable grade selection. Also, customer related lab applications addressing specific targets, using provided substrates.

Laboratory facilities are available in the following locations:

- USA – Baltimore, MD, supporting North America and Canada
- Germany – Worms, supporting Europe, Middle East and Africa
- Malaysia – Kuantan, supporting Asia-Pacific
- Japan – Atsugi, supporting Asia-Pacific
- Brazil – Sorocaba, supporting Latin America

Wherever you are located, you can always expect the same high quality of technical advice and support which is a pre-requisite for developing technical cooperation and successful business partnerships in the future.

Quality Management
Our Quality Management System takes a customer centric approach and is based on Grace Davison’s philosophy of continuous improvement in every area of the organization.

- All our facilities are ISO 9001 certified (our Worms and Düren plants are also ISO 14001 certified), and we implement internal and external audits to find ways to improve our services and processes.
- We employ the latest Statistical Process Controls (SPC) to monitor and analyze production and related work processes.
- We continuously monitor and improve our processes by using Six Sigma® & Lean Management tools.
- Our well-equipped Quality Control department works around the clock to ensure constant product quality.
- We continuously collect and assess customer information and feedback as an important factor in our QM program.

In order to meet the needs and expectations of our customers, the Quality Management program includes the functional divisions of sales and marketing, research and development as well as customer service. Our dedicated work force is our most important asset and customer satisfaction is our most important objective.

The Lean Six Sigma® Advantage
At Grace Davison, Lean Six Sigma® is part of the company’s culture for more than 10 years. To maintain Grace Davison’s high process standards, we employ the Lean Six Sigma® tools as an integral component of continuous improvement. These were designed to investigate process parameters, quantify their effects and optimize them in order to achieve the best possible results. Our Lean Six Sigma® initiative aims at improving both product consistency as well as production flexibility using advanced statistical methods and evaluation procedures. Our customers benefit from products of the highest quality.
**Safety Issues, Food Contact**

Safety is a priority at Grace Davison. Our products are non-toxic grades based on synthetic amorphous silicas. Most of our silica and aluminum-silicates products are approved for direct and indirect food contact by a variety of international authorities like the Food and Drug Administration (FDA) and the Scientific Committee of Food. For further information, our EHS-department (Environment, Health & Safety) is available to assist you.

As a premier specialty chemicals company, it is one of Grace’s utmost priorities to comply with all relevant legislation, including REACH. Therefore, in November of 2008 we undertook extensive efforts to achieve compliance of all our products, substances and formulations. Since the beginning of 2010, our main products, including synthetic amorphous silica, zeolites and synthetic amorphous silicates, are all registered under REACH. Regardless of which product you buy from us in the EU, you can be assured that all necessary steps have been taken to ensure continuous and smooth supply of your products.

**Global Scope**
Grace is a premier specialty chemical and materials company with more than 6000 employees located around the world. Our products are used by millions of people each day. Among many other things, we ensure the integrity of some of the world's major buildings and bridges, enhance the performance of your petroleum products and preserve the safety of your food.

Grace Davison has met all REACH requirements for the given deadline for Tier 1, December 1, 2010, and can hereby assure today’s and future customers full REACH compliance of its products. This assurance also includes the very diverse use of a spectrum of our products.