Catalyst Carrier

Newsletter

Issue 04 / 2011

Over the past year, we have reached out to you in the Catalyst Research & Manufacturing communitiy with a series of updates covering new and innovative materials. It is our wish that you could benefit from the diverse materials that Evonik Industries expressly developed with the design of catalysts in mind. In earlier Newsletters we described the advantages of Evonik technology in various powdered forms (available online: www.aerosil.com); in this Newsletter we would like to describe another convenient way to introduce fumed oxides into your catalyst formulations: AERODISP® Fumed Silica and Metal Oxides Dispersions.

Please come by and visit the Evonik Degussa booth at the upcoming North American Catalysis Society Meeting (NAM22)

Introducing AERODISP® – Fumed Silica and Metal Oxides Dispersions from Evonik

AEROSIL® Fumed Silica and AEROXIDE® Fumed Metal Oxides are well known throughout the industry as chemically highly pure fumed silica and fumed metal oxides. Due to their purity and well defined physical properties such as surface area and phase structure they are frequently used in catalytic applications such as in catalyst washcoats, in extrudates or as raw material for the synthesis of specialty zeolites. However, handling of fumed silica and fumed metal oxides often is challenging, due to the extreme fineness and fluffy structure of these products. To address this challenge Evonik Industries has been manufacturing dispersions based on fumed silica and silica/alumina mixed oxides since 1953. Today, we have added more products to that original set so that we now offer a wide variety of oxides, all of interest to the catalyst industries: TiO_2, Al_2O_3, ZrO_2, and several mixed oxide particles, such as SiO_2/TiO_2 or SiO_2/Al_2O_3.

Extremely Fine Dispersions by Unique Dispersion Technology

By using an advanced dispersing technology, with equipment that imparts 1000 times the shear energy as standard dispersion equipment, we are able to manufacture extremely fine particle metal oxide dispersions. These can be identified by an extra "X" at the end of the product name. AERODISP® W 740 X and VP Disp. W 2730 X dispersions based on AEROXIDE® TiO_2 P25 and AEROXIDE® TiO_2 P90, respectively, are manufactured using this technology. In fact, these dispersions, which are well suited for catalytic and photocatalytic applications, can only be made mono-disperse using this proprietary technology (see Figure 1). For a description of their properties, please refer to the summary table at the end of the Newsletter.

Figure 1a
40 % TiO_2, conventional, bimodal dispersion with high viscosity

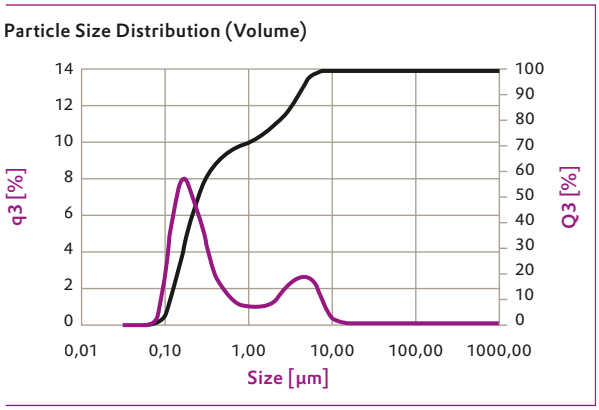
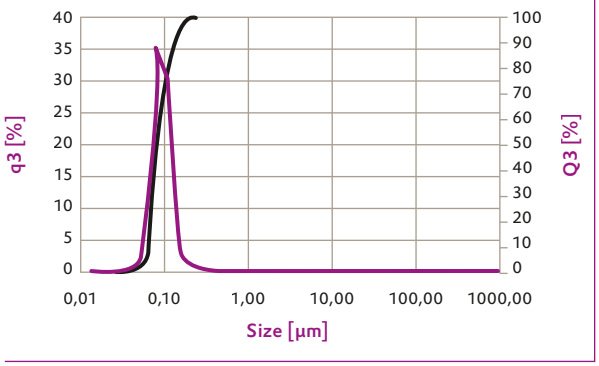


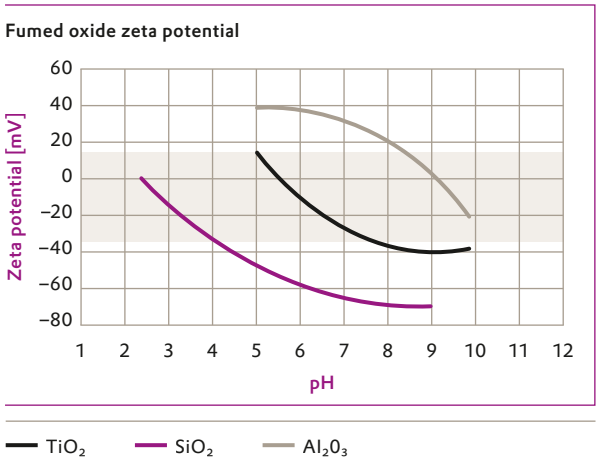
Figure 1b
AERODISP® W 740 X 40 % TiO_2, high energy milled, monomodal dispersion with low viscosity



Zeta Potential and Dispersion Stability for Fumed Silica and Metal Oxides

AERODISP® starts with the purity of AEROSIL® fumed silica and/or AEROXIDE® fumed oxides. A well studied dispersion process breaks down their agglomerated structure and disperses the resulting sub-micron aggregated particles in water without polymeric additives. Full stability against coagulation or settling is achieved by adjusting the surface charge of the dispersed particles through pH control. This charge adjustment depends on the particle nature as can be seen in Figure 2. Alkaline dispersions of silica, such as AERODISP® W 7520 are quite stable, and yet acidic versions with similar stability can be made, again without dispersants or polymeric stabilizers, e.g. AERODISP® W 7512 S – the acidic dispersion of AEROSIL® 200. Also from Figure 2, one can see that alumina dispersions exhibit their greatest stability under acidic conditions, but unlike silica, alumina dispersions such as AERODISP® W 630 consist of positively charged particles.

Figure 2
Zeta Potential of different fumed oxides depending on the pH value



The Value of AERODISP® in Catalyst Design

Using AERODISP® is a convenient way to bring the high purity of AEROSIL® and/or AEROXIDE® into the manufacture of catalysts. Metal impurities can be kept to well below 5 ppm and in some cases even below 1 ppm. The AERODISP® process is easily adjustable so that virtually any hydrophilic metal oxide powder can be dispersed in water. And with a wide variety of stabilizing agents available, choosing what goes into your catalyst formulation is always possible with AERODISP®.

Waterborne binders, most often including colloidal silica, are frequently used in catalyst manufacture to provide a tough, inorganic bond between particle ingredients in a catalyst system. The binder should be chemically pure and inert, able to withstand typical reaction temperatures, and possess high enough surface area in order to support maximum catalytic efficiency. AERODISP® offers all these characteristics and an important one in addition: ultrafine structure. Because of the high structure of AEROSIL® and AEROXIDE® particles, the bond it forms between larger particles tends to exhibit both a more open gel structure and, seemingly paradoxically, a tendency to form a mechanically stronger adhesion than do colloidals. This is likely due to the sintered interface between the nano-sized primary particles in AEROSIL®/AEROXIDE® agglomerates.

AERODISP® also is the simplest way to use the ultrafine aggregated structure of fumed metal oxides as a binding agent for extruded shapes. By simply dosing and stirring, the sub-micron particles with their high surface area can be added to a catalyst manufacture, and unlike colloidals they do not hard-pack when dried.

AERODISP® W 7520, for instance, is a generally useful starting point for binder formulation. It consists of AEROSIL® 200 (the 200 m^2/g fumed silica powder) dispersed in de-ionized water (20 wt% silica) and stabilized to an alkaline pH with ammonium hydroxide. And while the average primary particle size for AEROSIL® 200 is 12 nm, the particles in AERODISP® W 7520 consist of aggregates of primary particles and these aggregates average in particle size at ~100 nm (as seen in Figure 3). Using slurries is easy because the viscosities of most AERODISP® dispersions are typically quite low, 10–100 mPa·s, and do not change over a wide degree of shear. The general methods used with colloidal silica to grow gels with predetermined pore structures can be duplicated with AERODISP® but in this case yielding carriers with added dimension of ultrafine structure due to the fumed origin of the starting material.

Figure 3
Particle size distribution of AERODISP® W 7520, 20% SiO_2, monomodal dispersion

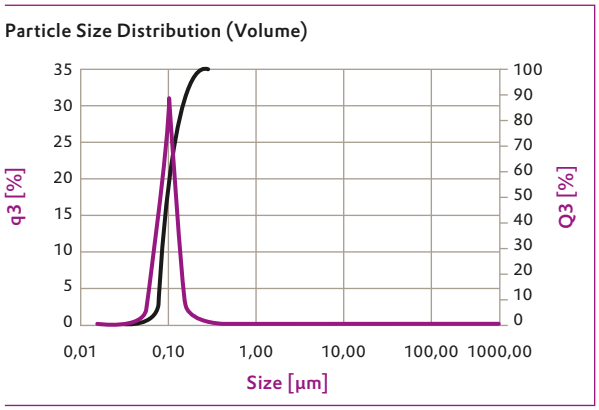
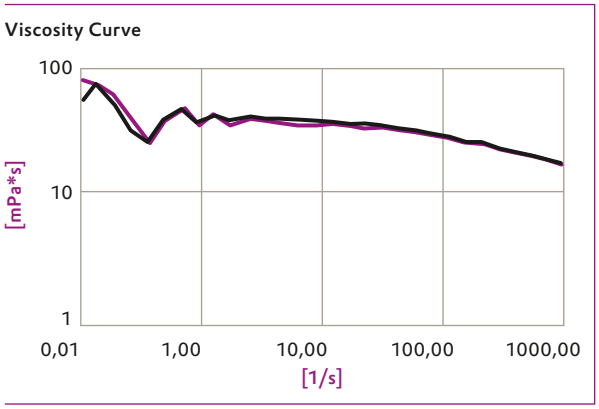


Figure 4
Viscosity curve of AERODISP® W 7520, 20% SiO_2



In another application, washcoats for automotive exhaust catalysts often contain fumed metal oxides as carrier material. Such catalysts encounter high temperature stress during their lifecycle and so dispersions of mixed fumed metal oxides such as VP Disp. W 340 (a dispersion based on silica doped with alumina that shows increased sintering stability), VP Disp. W 6840 X or VP Disp. W 6740 X (dispersions based on titania doped with silica with increased temperature stability) are of particular interest. For more information on doped titania grades refer to Catalyst Carrier Newsletter #1 (Available on: www.aerosil.com).

A further valuable application of AERODISP® is in the manufacture of specialty zeolites, those that require highly pure silica or metal oxides. Using AERODISP® facilitates the incorporation of fumed silica/metal oxide and because of their dispersion form precise dosing and homogenization are achievable.

Simply put, AERODISP® provides the value of AEROSIL® and AEROXIDE® in a convenient form.

Summary and Details for AERODISP®

- Dispersion of fumed silica or fumed metal oxide aggregates
- Available in acidic and basic versions
- Mono-disperse and narrow Particle Size Distribution
- Easy to use, low viscosity & stable
- Available for AEROSIL® fumed silica, but also for the difficult to disperse fumed metal oxides such as AEROXIDE® TiO_2 P25, AEROXIDE® TiO_2 P90, and AEROXIDE® AluC
- The easiest way to introduce fumed oxides into: Extrudates, Washcoats, and Zeolites

Typical data of selected AERODISP® dispersions

The following table gives an overview on some basic physico-chemical characteristics of selected AERODISP® dispersions. For more information please also have a look into our Industry Brochure 0207[2] and on our website www.aerosil.com. Further dispersions of hydrophilic and hydrophobic silica and metal oxides are available on request.

Table 1
Data of selected AERODISP® dispersions. The data represent typical values and are not part of the specification. Developmental products are labeled with the VP Disp. designation.

AERODISP® grade	Chemical composition	Solids content[1] [wt.%]	pH-value[2]	Viscosity[3] [mPa·s]	Density [g/cm³]	Stabilizing Agent/Remarks
AERODISP® W 7520	SiO_2	20	9.5 – 10.5	≤ 100	1.12	Ammonia
AERODISP® W 7512 S	SiO_2	12	5 – 6	≤ 100	1.07	
VP Disp. W 1250	SiO_2	50	9.5 – 10.5	≤ 2000	1.37	Ammonia
AERODISP® W 740 X	TiO_2	40	6 – 9	≤ 1000	1.41	
VP Disp W 2730 X	TiO_2	30	6 – 8	≤ 5000	1.29	
AERODISP® W 630	Al_2O_3	30	3 – 5	≤ 2000	1.26	
VP Disp. W 340	SiO_2, doped with Al_2O_3	40	3 – 5	≤ 1000	1.28	
VP Disp. W 6740 X	TiO_2, doped with SiO_2	40	6 – 9	≤ 1000	1,39	
VP Disp. W 6840 X	TiO_2, doped with SiO_2	40	6 – 9	≤ 1000	1,40	

1) Solid contents may vary +/–1 %
2) Measured according to EN ISO 787–9 method
3) Measured according to DIN EN ISO 3219 at a shear rate of $100s^{-1}$

References

[1] Catalyst Carrier Newsletter Issue 1, New heat resistant fumed Titania catalyst-base materials – Evonik Degussa GmbH, April 2010

[2] Industry Brochure 0207, AERODISP® Fumed Silica and Metal Oxide Dispersions, Evonik Degussa GmbH, July 2010

Evonik´s Silica business line and/or Evonik´s Catalysts business line will be present at these events

Trade show appearance, conference, name of event	Date	Where
22nd North American Meeting (NAM)/NACS	5 – 10 June 2011	Detroit, MI, USA
CPhI China	21 – 23 June 2011	Shanghai, China
EuropaCat X	28 August – 2 September 2011	Glasgow, Scotland, UK
CPhI Worldwide	25 – 27 October 2011	Frankfurt am Main, Germany
CPhI India	30 November – 2 December 2011	Mumbai, India

North America

Evonik Degussa Corporation
Inorganic Materials
379 Interpace Parkway
P.O. Box 377
Parsippany, NJ 07054-0677
USA

PHONE +1 888 745-4227
FAX +1 732 981-5310
catalyst-carrier-nafta@evonik.com

Asia/Pacific

Evonik Degussa (SEA) Pte. Ltd.
Inorganic Materials
3 International Business Park
#07–18 Nordic European Centre
Singapore 609927

PHONE +65 6 890-6031
FAX +65 6 890-6872
catalyst-carrier-asia@evonik.com

EVONIK INDUSTRIES

Europe/Middle-East/ Africa/Latin America

Evonik Degussa GmbH
Inorganic Materials
Rodenbacher Chausse 4
63457 Hanau-Wolfgang
Germany

PHONE +49 6181 59-4858
FAX +49 6181 59-4096
catalyst-carrier-eu@evonik.com

www.evonik.com

Evonik. Power to create.