BASF
We create chemistry

High Performance Spherical Catalysts Carriers

Spherical Catalysts Carriers

BASF is a global leader in catalyst production. Catalysts manufacturing is a core expertise which relies on decades on commercial experience. We offer a wide range of spherical porous carriers to comprehensively meet the needs of heterogeneous catalyst manufacturers. Substrate selection is critical, and requires deep understanding of physical and chemical properties of the chosen carrier. BASF produces catalyst support spheres with unique and controlled manufacturing processes to provide suitable carriers for numerous applications.

BASF offers alumina-based (SAS and CSS) and silica-based (Perlkat) carrier product lines to meet most stringent customer requirements. Whether you need an interacting, bifunctional or chemical resistant carrier, BASF can supply an appropriate sphere. Vast experience allows our in-process and post treatments to alter and tune-in density, pore structure, activity and thermal stability.

High Performance Spherical Catalysts Supports

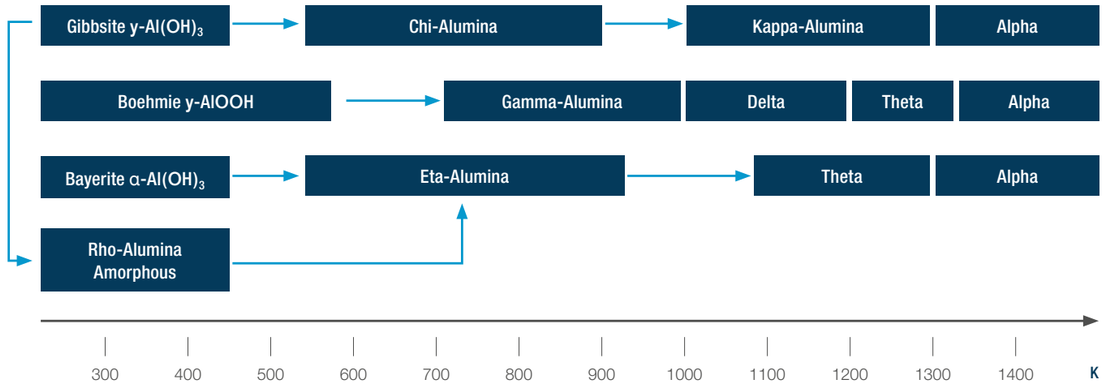
- **Superior physical integrity**
  - Low abrasion
  - Low attrition
  - Exceptional crushing strength
- **Uniform size**
  - Minimizes channeling
  - Low pressure drop
  - Optimal flow distribution
- **Controlled pore structure and surface area**
  - Very narrow pore size distribution
  - Mono- and bimodal porosity
  - Distinct phase composition
  - Controlled surface chemistry

Alumina-based Catalyst Carriers*

Summary Table: SAS and CSS Spheres (Alumina)

Property	Unit	SAS-200	SAS-90	SAS-40	SAS-10	CSS-350	CSS-165
Al_2O_3	wt %	99.6	99.6	99.5	99.5	99.6	99.6
SiO_2	wt %	0.02	0.02	0.25	0.25	0.02	0.02
Na_2O	wt %	0.25	0.25	0.25	0.25	0.3	0.3
Surface Area	m^2/g	200	90	40	10	350	165
Pore Volume	cc/g	0.5	0.5	0.5	0.55	0.5	0.55
Abrasion	wt %	0.05	0.05	0.05	0.1	0.05	0.25
Bulk Density	kg/m^3	785	785	800	800	770	750
Crush Strength	lb per 1/8"	22	19	15	10	30	25
Phase		γ	δ, γ	δ, θ, α	α	γ, χ	γ, χ
Standard Size		1/8", 1/16"	1/8", 1/16"	1/8", 1/16"	1/8", 1/16"	1/8", 1/16"	1/8", 1/16"

Alumina Transformations Phase Diagram



(K.Wefers & C.Misra, Alcoa Technical Paper No.19, 1987)

Manufacturing Routes

SAS Spheres

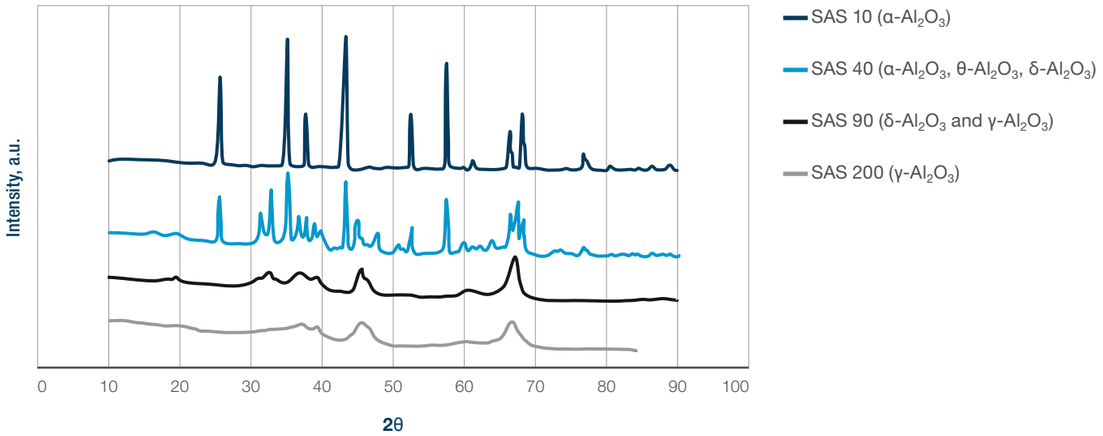
CSS Spheres

*Typical properties

SAS Spheres Phase Composition

The SAS product line offers phase-controlled alumina to maximize performance of a catalyst under most demanding reaction conditions.

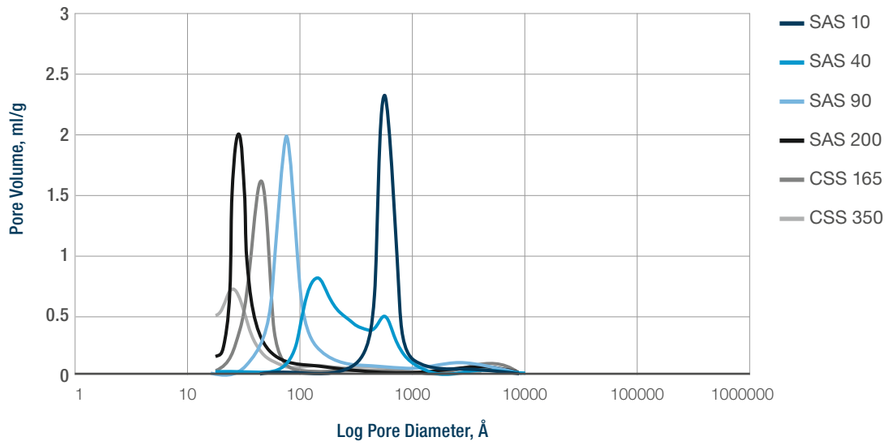
SAS spheres production process allows to produce phase-selective alumina supports with no residual amounts of chi or eta-alumina. Purity of the phase is controlled by precise temperature selection in a production process and high quality standards imposed on feed material. BASF also offers custom-produced spheres where phase purity and crystallinity are adjusted per customer's specific request.



SAS and CSS Spheres Porosity

SAS and CSS spheres are characterized by tailored porosity ranging from essentially microporous to macroporous pore systems.

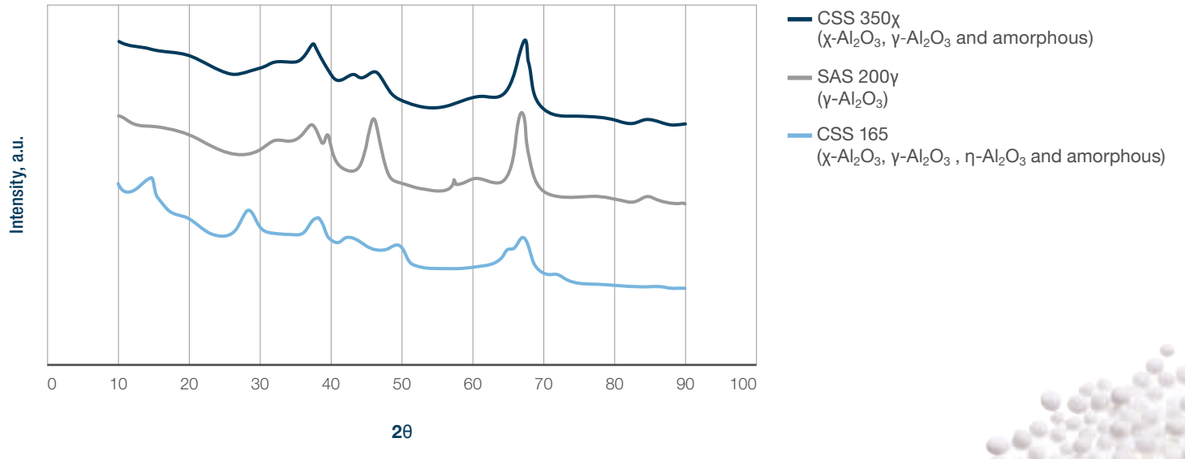
SAS and CSS spheres exhibit engineered porosity that enables good dispersion of the active component and enhanced mass-transport characteristics. SAS-10, 90 and 200 feature well defined monomodal pore size distribution and SAS-40 offers bimodal pores. CSS spheres are offered in two types: high surface area microporous CSS350 to maximize surface activity and metal-binding properties and intermediate surface area CSS165 to shift micropores to mesopores enabling more efficient mass transport.



CSS Spheres Phase Composition

CSS spheres provide mixed phase and amorphous active surface suitable for synthesis of controlled metal dispersion catalysts.

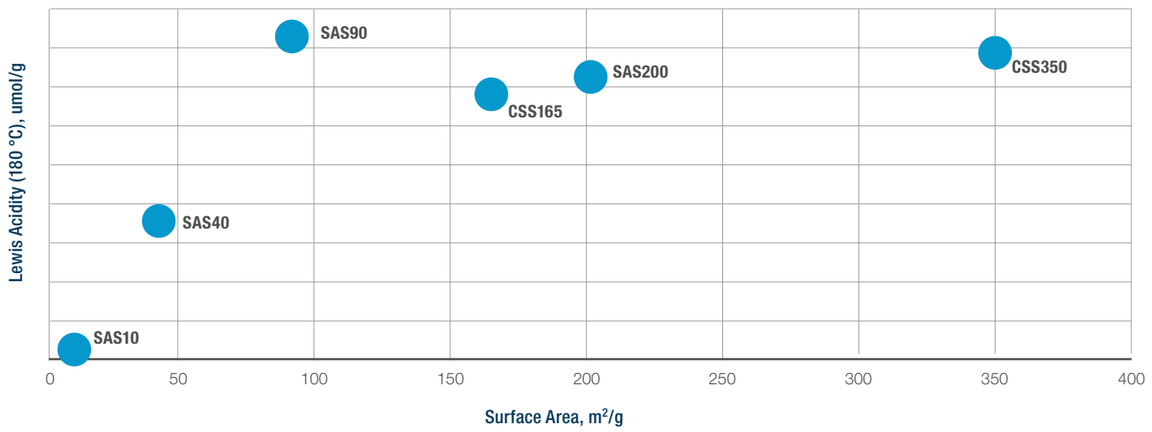
Unlike SAS alumina spheres, CSS supports are designed to deliver maximal surface area for most efficient distribution of the supported active component. CSS spheres exhibit mixed phase composition and present most cost-efficient solution for catalyst producers looking for stable, robust and performing alumina supports.



SAS and CSS Spheres Acidity

SAS and CSS spheres offer wide range of Lewis Acidities suited for most demanding catalyst applications.

BASF alumina spheres are characterized by wide range of Lewis acidities. Surface acidity is correlated with a phase composition and represents an important parameter in a catalyst design. Combined SAS/CSS alumina spheres portfolio offers products covering the whole spectrum of surface reactivities: from highly inert/less reactive (SAS-10) to highly functional and highly developed surfaces (CSS, SAS). This combination enables producers to choose material matching their needs and/or explore different portfolio products in their processes.

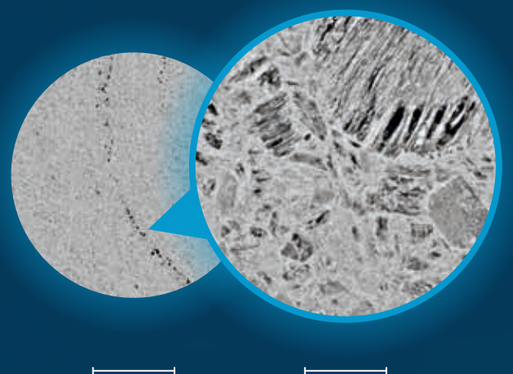


SAS and CSS Spheres Macrostructure

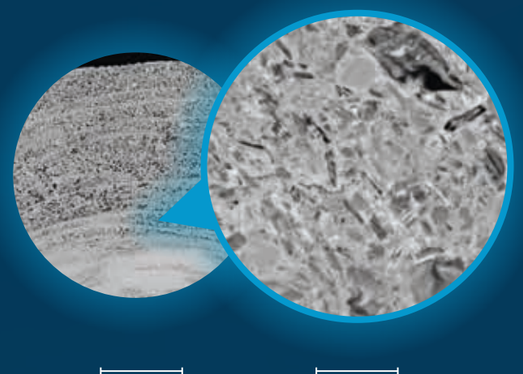
Primary alumina particles packings SAS to CSS spheres are built to optimize mass transport and surface chemistry.

The macrostructure of alumina spheres and primary alumina particles packing often needs to be considered when developing catalysts for highly mass transport limited processes. CSS spheres consist of less densely packed agglomerates allowing for higher fraction of inter-particle voids while SAS spheres exhibit relatively dense and robust matrix making those spheres very stable under aggressive conditions

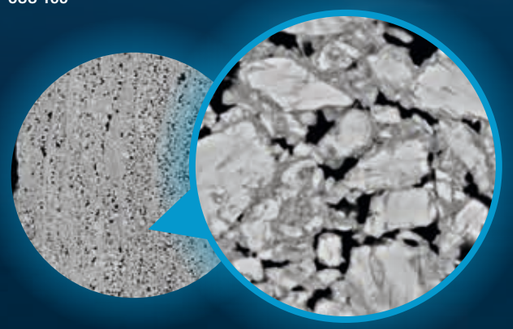
SAS 10



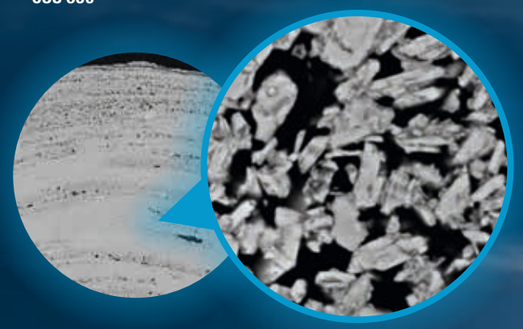
SAS 200



CSS 165



CSS 350



Alumina-based Catalyst Carriers

Silica-based Catalyst Carriers*

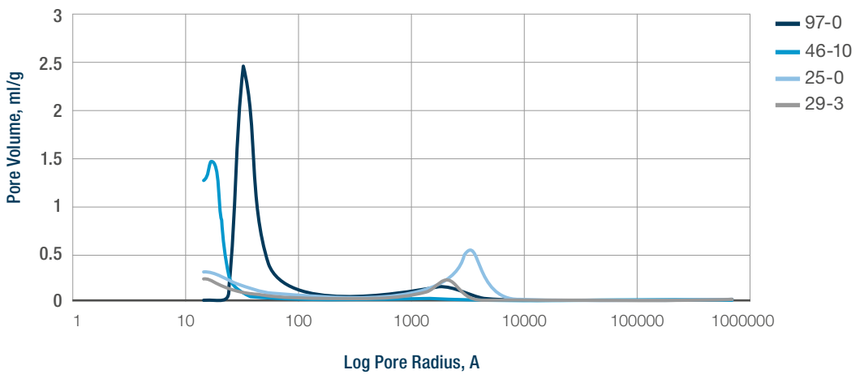
Summary Table: Perlkats Spheres (Silicagel)

Property	Unit		Perlkat 97-0	Perlkat 46-10	Perlkat 25-0	Perlkat 29-3
SiO_2	wt %	min	99	82	99	96
Al_2O_3	wt %		0.5 max	9.0–16.0	0.5 max	2.0–4.0
Na_2O	wt %	max	0.1	0.1	0.1	0.1
Surface Area	m^2/g	min	300	330	700	630
Pore Volume	cc/g	min	0.75	0.4	0.4	0.4
Attrition	wt %	max	0.5	0.1	0.1	0.1
Bulk Density	kg/m^3	min	450	650	550	600
Crush Strength	N/bead	min	100	100	30	50
Phase			Amorphous	Amorphous	Amorphous	Amorphous
Standard			3 to 5 mm	1 to 4 mm	1 to 4 mm	1.5 to 5 mm

Perlkat Spheres Porosity

Perlkats portfolio offers substantial flexibility when selecting a sphere with appropriate porosity: from microporous monomodal to highly macroporous and bimodal.

Pore size distribution in Perlkat spheres is tunable. Customization of pore structure is feasible as per customer's request.

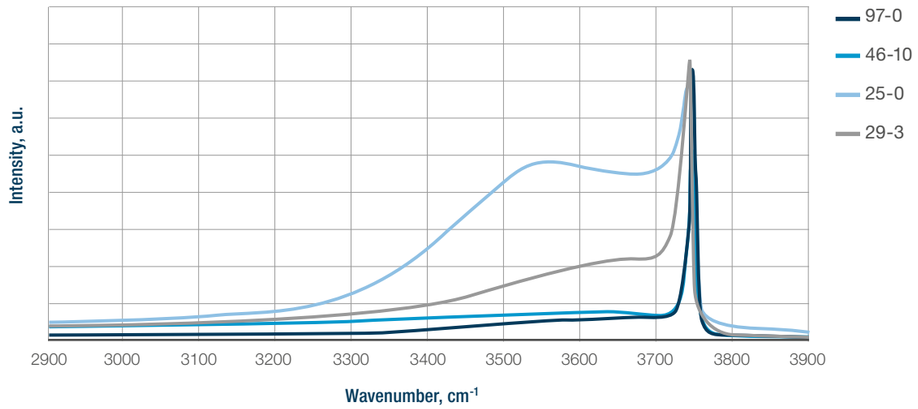


*Typical properties

Perlkat Spheres Surface Chemistry

Perlkat 25-0 offers highly hydroxylated surface with substantial contribution from hydrogen bonded Si-OH groups. Perklat 97-0 exhibits mostly isolated silanols (Si-OH) providing virtually a non-acidic, non-reactive surface.

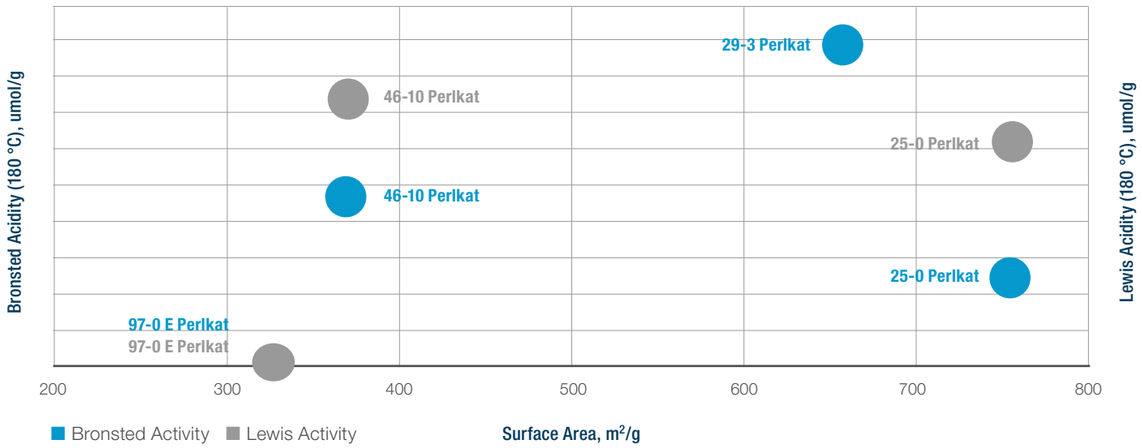
Surface chemistry SiO_2-based supports is often affected by hydroxyls coverage and types of hydroxyl groups present. Perlkats portfolio features diversity of surface hydroxyls concentrations enabling rich surface functionality. BASF also offers customized solutions where hydroxyls concentration in a product are adjusted based on a specific customer request.



Perlkat Spheres Acidity

Perlkats portfolio features spheres with varying surface acidity: from essentially non-acidic 97-0 to highly acidic 29-3.

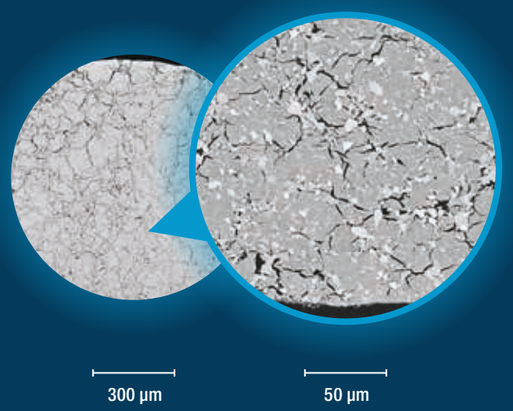
Surface acidity (Bronsted and Lewis) has to be controlled to yield optimal performance of the catalyst and avoid side reactions. Type of the acid site defines chemical reactivity of the surface and what type of reactions those sites promote. Lewis acidity is normally associated with alumina while Bronsted acidity is arising due to the presence of bridged hydroxyl groups. Perlkats portfolio highlights pure SiO_2-based supports as well as alumina-promoted spheres. Adding alumina into the composition induces Lewis acidity but also generates Bronsted sites. Perlkat 97-0 is essentially non-acidic while Perlkat 29-3 exhibit substantial Bronsted acidity.



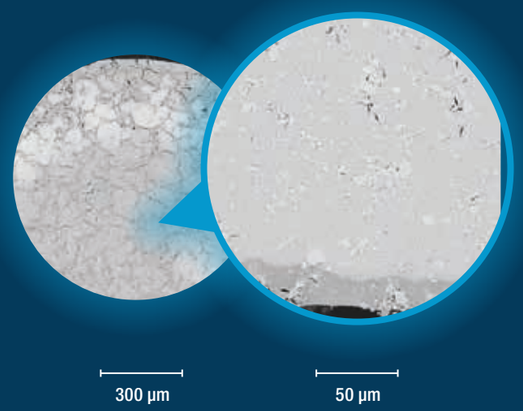
Perlkat Spheres Macrostructure

Porosity of the support sphere is an important characteristic in catalyst development. Selecting a sphere with optimal pore size distribution is crucial to enhance mass-transfer processes and maximize catalytic activity. Standard Perlkat portfolio offers microporous and macroporous materials with varying contributions of micro and macro pores.

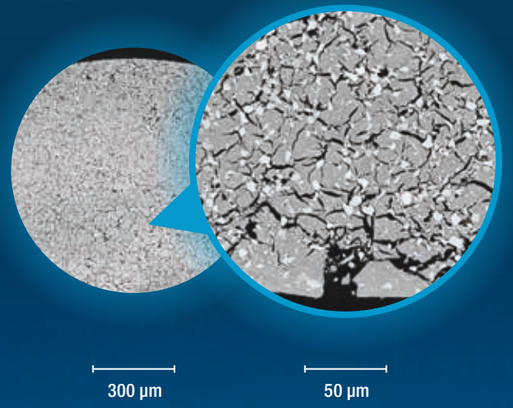
Perlkat 97-0



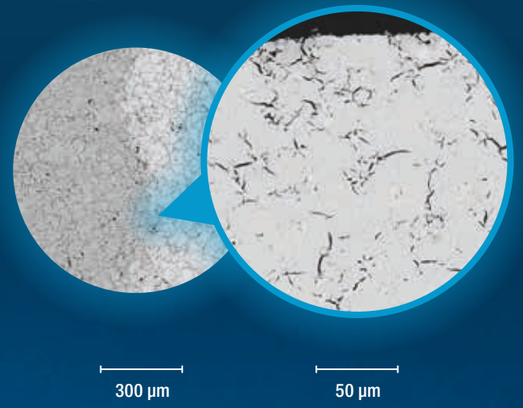
Perlkat 46-10



Perlkat 25-0



Perlkat 29-3



Silica-based Catalyst Carriers

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