POLYOLEFINS
Catalysts & Components – Accelerating Your Chemistry®
The purple box symbolizes performance in five dimensions:

**TAILORED SOLUTIONS**
Your goals, needs and wishes are unique – we’ll develop the right solution for your process.

**SPEED**
Time is of the essence for our customers – our teams react swiftly and flexibly to your special wishes. Irrespective of whether the catalyst is based on your recipe or ours, we specialize in scaling-up and on producing sophisticated catalysts on a commercial scale.
STRENGTH
Evonik catalysts are always heavy-duty performers – you can count on our strength as well as the power of our catalysts.

LONG LIFE
Efficiency and long-term reliability are decisive for catalytic processes – that’s why Evonik catalysts are always designed for a long service life.

SERVICE
Technical customer service, high throughput screening, metal recovery – Evonik catalysts come with a full service package.
TOGETHER WE BRING CATALYST IDEAS TO LIFE

Catalysts: the No. 1 value generator in the chemical industry. More than 80 percent of all chemical products are manufactured by means of catalytic processes. Expertise in harnessing the power of catalysts is second nature to us – we can help you significantly reduce energy and resource consumption, or develop new products. As an international leading provider of catalytic technologies, we serve the markets:

- Life Sciences & Fine Chemicals
- Industrial & Petrochemicals
- Polyolefins
Evonik, the creative industrial group from Germany, is one of the world leaders in specialty chemicals. Profitable growth and a sustained increase in the value of the company form the heart of Evonik’s corporate strategy. Its activities focus on the key megatrends health, nutrition, resource efficiency and globalization. Evonik’s customers benefit from its innovative products and integrated technology platforms. Evonik is active in over 100 countries around the world. As part of Evonik Resource Efficiency GmbH, the Business Line Catalysts lives up to the principles of resource efficiency. Our products enable and continuously improve production efficiency.

**SALES 2017:** 14.4 billion

**ACTIVE IN OVER:** 100 countries

**EMPLOYEES:** more than 36,000

**EVONIK IS A MEMBER OF**

- the European Catalyst Manufacturers Association (ECMA)
- the Catalyst Manufacturers Association of Japan (CMAJ)
- the Synthetic Organic Chemical Manufacturers Association (SOCMA)
- the Drug, Chemical & Associated Technologies Association (DCAT)
- the American Chemistry Council (ACC)
- the Catalysts Society of Japan (CSJ)
Today, Evonik has eight major catalyst brands for homogeneous and heterogeneous catalytic processes under one roof. This diverse portfolio of catalysts gives us the flexibility to find the most cost-efficient solution for your needs. With its catalysts for batch, semi-batch and continuous processes, Evonik serves the following markets:

### MARKETS & BRANDS

<table>
<thead>
<tr>
<th>Life Sciences &amp; Fine Chemicals</th>
<th>Industrial &amp; Petrochemicals</th>
<th>Polyolefins</th>
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<tbody>
<tr>
<td>Aerolyst®</td>
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<td>catMETium®</td>
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<td>Catylen®</td>
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<td>KALCAT™</td>
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<td>Metalyst™-MC</td>
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<td>MONCAT™</td>
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<td>Noblyst®</td>
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<td>Octolyst®</td>
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GLOBAL PRESENCE

OUR MISSION

“Together we bring catalyst ideas to life, creating value by our passion and focus.”

OUR VISION

“To be globally recognized as the preferred partner for major catalyst users, and to develop and attract talented people for our international team.”
We have built our business models around your needs in relation to catalyst solutions. There are two business models: the product and project business.

**PRODUCT BUSINESS**
- Products from our portfolio
- Evonik proprietary products and production know-how
- Ready to use

**PROJECT BUSINESS**
- Catalysts that are customized in close cooperation with the customer

**TRUE PARTNERSHIP FOR OPTIMIZED CATALYST SOLUTIONS**
In both business models, we leverage our core competencies. We are creative in finding new solutions and are open to ideas that are not obvious. We specialize in scaling up and producing sophisticated catalysts on a commercial scale.

Our core competencies:
- Designing high performance robust catalysts
- Producing in commercial quantities
- Delivering on our promises
- Professional project management
**THE CATYLEN® BRAND**

CATYLEN® IS EVONIK’S BRAND NAME FOR OLEFIN POLYMERIZATION COMPONENTS AND CATALYSTS. THE PRODUCT LINE CONSISTS OF CATYLEN® S (SUPPORTS) AND CATYLEN® D (DONORS).

We offer a specialized product portfolio of catalyst components used in polymerization processes. These products are proprietary to Evonik, can be readily supplied and are produced on a commercial scale. However, it is important for you to know that Evonik’s proprietary product and technology portfolio is broader and can also be accessed via a project.

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### STEREOMODIFIERS

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Chemical Name</th>
<th>CAS Registry Nr.</th>
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</thead>
<tbody>
<tr>
<td>Catylen® D 300</td>
<td>C donor</td>
<td>Cyclohexylmethyldimethoxysilane</td>
<td>17865-32-6</td>
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<tr>
<td>Catylen® D 400</td>
<td>D donor</td>
<td>Dicyclopentyldimethoxysilane</td>
<td>126990-35-0</td>
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<tr>
<td>Catylen® D 500</td>
<td>DIB</td>
<td>Diisobutyldimethoxysilane</td>
<td>17980-32-4</td>
</tr>
<tr>
<td>Catylen® D 600</td>
<td>DIP, P donor</td>
<td>Diisopropylidimethoxysilane</td>
<td>18230-61-0</td>
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<tr>
<td>Catylen® D 700</td>
<td>IBIP</td>
<td>Isobutylisopropyldimethoxysilane</td>
<td>111439-76-0</td>
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<tr>
<td>Catylen® D 800</td>
<td>NPTMS</td>
<td>n-Propyltrimethoxysilane</td>
<td>1067-25-0</td>
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<tr>
<td>Catylen® D 900</td>
<td>IBMDMS</td>
<td>Isobutylmethylmethoxysilane</td>
<td>18293-82-8</td>
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<tr>
<td>Catylen® D 1000</td>
<td>TEOS</td>
<td>Tetraethoxysilane</td>
<td>78-10-4</td>
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<td>Catylen® D 1100</td>
<td>TMOS</td>
<td>Tetramethoxysilane</td>
<td>681-84-5</td>
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<td>IBTEO</td>
<td>Isobutyltriethoxysilane</td>
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<td>n-Propyltriethoxysilane</td>
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<td>IBTMO</td>
<td>Isobutyltrimethoxysilane</td>
<td>18395-30-7</td>
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<tr>
<td>Catylen® D 1500</td>
<td>CEDMS</td>
<td>Cyclohexylethylmethoxysilane</td>
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## ZIEGLER AND ZIEGLER-NATTA CATALYST PRECURSORS

<table>
<thead>
<tr>
<th>Product</th>
<th>Process</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catylen® S 101</td>
<td>Gas phase</td>
<td>PP</td>
</tr>
<tr>
<td>Catylen® S 102</td>
<td>Slurry</td>
<td>PE (HDPE, UHMWPE)</td>
</tr>
<tr>
<td>Catylen® S 103</td>
<td>Gas phase, bulk</td>
<td>PE, PP</td>
</tr>
<tr>
<td>Catylen® S 200</td>
<td>Slurry</td>
<td>PE (HDPE, UHMWPE)</td>
</tr>
<tr>
<td>Catylen® S 300</td>
<td>Gas phase, bulk</td>
<td>PE, PP</td>
</tr>
</tbody>
</table>

PP = Polypropylene, PE = Polyethylene, HDPE = High-density polyethylene, UHMWPE = Ultra high molecular weight polyethylene
INTRODUCTION TO POLYOLEFINS

Polyethylene (PE) and polypropylene (PP) have come to be the most important polymers in the world: in 2016, the quantities produced for both plastic materials together amounted to more than 160 million tons; the estimated worldwide capacity for both polymer classes amounted to more than 205 million tons. Ziegler-Natta (ZN) catalysis, for which Karl Ziegler and Giulio Natta were awarded the Nobel Prize for chemistry in 1963, is still widely used today. In PE production, it is used in 50 percent of all cases and in the production of PP, more than 95 percent of the time. The end products made from these versatile polymers include pipes for gas and water, fibers for clothing and carpets, foils for packaging, molded parts for bottles, appliance housings and car parts. Our Catylen® family of products are key components of the Ziegler and ZN catalysts; although they are used in very small amounts, they have a profound influence on the ultimate properties of the polymers. An average PP plant may produce 30000 kg of polymer per hour ... while consuming only 1 kg of donor!
Polypropylene (PP) is a thermoplastic polymer made by polymerization of propylene. It is used in a wide variety of applications including food packaging, ropes, textiles, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components and polymer banknotes.

Isotactic, syndiotactic and atactic polypropylene are distinguished from one another, depending on the position of the methyl groups relative to the polymer chain. Various polymerization processes have been developed which can be run in bulk loop/gas phase (Spheripol®, Borstar®) or in the gas phase alone (Unipol™ PP, Novolen®, Innovene™ PP, Horizone PP). The end use of the polypropylene will ultimately decide the route required to achieve the desired properties. The various types of polypropylene, for example, homopolymer, impact copolymer or random copolymer will use a variety of catalyst components which are heavily dependent upon the licensed process in use.
POLYETHYLENE APPLICATIONS

Polyethylene (PE) is a thermoplastic polymer made by polymerization of ethylene. It is used in a wide variety of applications where blow molding, injection molding or extrusion coating can be applied.

Polyethylene is the most common polymer and is produced on a multi-million ton scale annually.

HDPE / UHMWPE

FOR EXAMPLE
Evonik’s unique Catylen® S portfolio enables our customers to produce Ziegler type catalysts suitable for slurry phase polyethylene processes.

Our Catylen® S family provides a narrow span (< 1) and financially advantageous alternative to the MgCl₂(EtOH), support based Ziegler catalyst route for the production of commodity as well as specialty PE grades. Evonik’s expertise in producing specific Catylen® S 100 and S 200 grades based on customer needs allows the manufacturing of tailor-made Ziegler catalysts for the production of a variety of PE grades, such as ultra high molecular weight PE (UHMWPE), high-density polyethylene (HDPE) and medium-density polyethylene (MDPE).
PACKAGING & SERVICES

Packaging

Standard packaging size
- Catylen® D: 216.5 liter steel drums/4 drums per pallet
- Catylen® S: 100 liter steel drums/5 drums per pallet
- Minimum order size: full pallets in order to optimize handling by freight forwarders and shipping companies

Custom packaging available upon request
• Larger bulk packaging
  - Catylen® D: 375, 850 or 1440 kg tank; containers for leasing
  - Catylen® S: up to 500 kg drum or big bag
• Smaller/sub packaging available on request

How you benefit from our custom packaging
• Tank containers for Catylen® D:
  - Donor is fed into the process under pressure in a closed system; no exposure to moisture during use
  - Easy changeover of donors possible
  - No separate donor feed or storage tank is required
  - Bulk shipments reduce deliveries and repeated handling by operators
  - Cost savings from elimination of drum disposal
• Big bag system Catylen® S:
  - No dust issues due to closed system
  - No exposure to moisture and air during material transfer
  - Reduced handling effort compared to drums
  - Cost savings from elimination of drum disposal
The right packaging, the right particle size, the required dilutions – Evonik helps to ease your production processes.

Catylen® Samples

• Catylen® samples are available upon request. Please see the back cover of this brochure for contact details, or visit our website at: www.evonik.com/catalysts
• Evonik has one of the largest donor libraries (with more than 70 donors) and undertakes lab synthesis of donors. You can order samples from this library for your projects.
Catalyst Supports and Donors

In collaboration with customers, Evonik develops, scales up and manufactures donors and catalyst supports. This is done in the context of a project that follows one of the three categories described below. The products are created within an exclusive framework and a one-on-one business relationship.

Project Categories

- **Joint development**
  - Product and process needs to be developed; close interaction between the customer and Evonik

- **Custom design**
  - Product needs to be developed for existing commercial application

- **Custom manufacturing**
  - Product lab recipe exists, but has not yet been produced commercially

**Characteristics of a project**

- All projects are governed by contracts
- A confidentiality agreement protects each party’s intellectual property rights and allows a free flow of information
- The collaboration contract defines the scope and goals of the project and the commercial conditions
- By definition, all projects run on an exclusive basis

**Services**

- Whichever business model you choose, all the products come embedded in service packages
- Trained staff in every region of the world provides you with the highest level of technical service
- We also provide custom packaging, help you with the safe and correct handling of our products, and tailor our logistics to your specific needs
Catalyst supports projects

- Allow you to optimize the morphology of your catalyst and ultimately the final polyolefin
- Provide you with a skilled partner for scaling up new catalysts
- Increase flexibility in the use of catalyst types and qualities

New donor structures

- We offer custom syntheses of novel internal and external donor structures
- We scale up and produce new donor structures
- We are experienced in fast transfer from lab to commercial production
- Production facilities are available for quantities of several hundred kilograms to several hundred tons

Take advantage of our extensive know-how in bringing catalyst ideas to life, and benefit from our production capabilities and catalyst expertise.
Material Safety Data Sheets (MSDS) can be obtained from your local sales representative or from:

Evonik Resource Efficiency GmbH
Postcode 713/303
Product Safety Department
Rodenbacher Chaussee 4
63457 Hanau-Wolfgang
Germany
sds-im@evonik.com

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