

Catalysts for the Fine Chemicals Industry

Enabling Faster Speed to Market

Fine Chemical Catalysts Toolkit

The cost-effective production of active pharmaceutical ingredients, agrochemicals, nutrition components or flavors and fragrances gains more and more importance in industry. Catalysts play a key role in most reaction steps and their optimum selection and operation ensures the highest process yields and efficiencies. This also means lower by-product formation and higher sustainability of the process. BASF is dedicated to providing cutting edge catalyst technology for all facets of this market.

Making life better for all

BASF's catalysts have helped the industry produce drugs and chemicals for many decades. Continuous product development and the broad portfolio of BASF has helped many new processes to go on-stream. BASF was the first to develop commercial catalysts and to use them for their own production some 100 years ago. With the integration of Engelhard in 2006, BASF is now the biggest producer of catalysts worldwide. The combined power of chemical and catalyst experience and precious metal handling makes BASF the ideal partner for you. In addition to catalysts, BASF offers inorganic reaction components as well as organic building blocks to the industry. Making life better for all – BASF is committed!

Service

BASF knows that our success is dependent upon your success. This is why our goal is to provide leading technologies that are supported by outstanding customer and technical services. Selection of the best catalysts, full-loop concept including catalyst recycling and hedging of the precious metals will help you to achieve bottomline results efficiently and effectively. For additional information, please do not hesitate to contact us.



Heterogeneous Precious and Base Metals Catalysts

BASF's expertise in developing precious and base-metal based catalysts has led to products that enable markedly increased process productivity. Our outstanding expertise in surface and material science is used to constantly develop novel heterogeneous catalysts. The major catalytic activity is determined by the principal metal(s) present on the catalyst, by the support characteristics and by the manufacturing technology. BASF offers a variety of precious metals (for example Pd, Pt, Rh, Ru, Ir, Au, Ag) dispersed on a wide range of supports like carbon, alumina, silica or titania, available as powders, extrudates, tablets or spheres. Base metals (mainly Ni and Cu) supported and passivated as easy-to-handle powder catalysts, and skeletal metals materials round out our portfolio.

Our state-of-the-art precious metal deposition technologies allow us to optimize the performance of catalytic materials and to fine-tune formulations to the specific needs of our customers' chemistry and equipment. Examples of recent innovations are our Blocking Group Removal catalysts (see next page), which enable robust and cost-effective deprotection reactions, and our NanoSelect™ Technology. NanoSelect catalysts are characterized by unimodal metal particles on the nanometer scale. This greatly increases the metal surface area available per gram, boosts the catalytic activity and demonstrates different catalytic behavior.

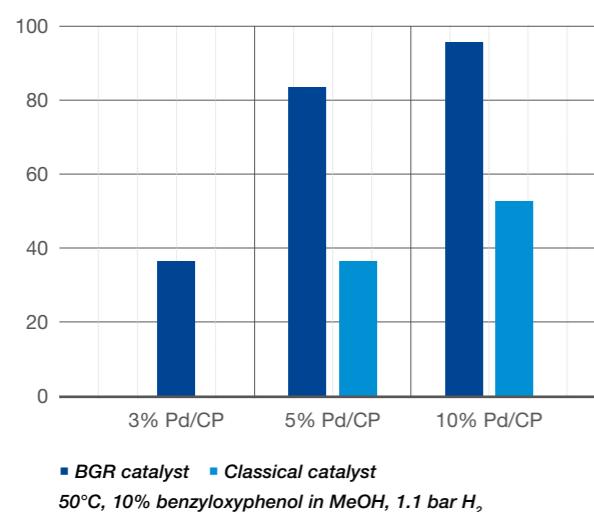
BASF catalysts sample kits are available to identify the best catalyst for each specific process, allowing a rational approach towards the development of the catalytic steps in any organic synthesis. The best catalyst from the sample kit selection may already fulfill your requirements, or serve as the starting point for improved catalysts tailor-made for your reactions. BASF is offering specially designed sample kits in collaboration with STREM Chemicals, Inc. (For example general purpose kits and deprotection kits). These kits are available on the web at www.strem.com/BASF. For commercial quantities please call one of the regional offices of BASF.

Please contact your BASF expert to discuss and fine-tune the catalytic approach to the needs of your special chemistry and process, and to select the right catalyst.

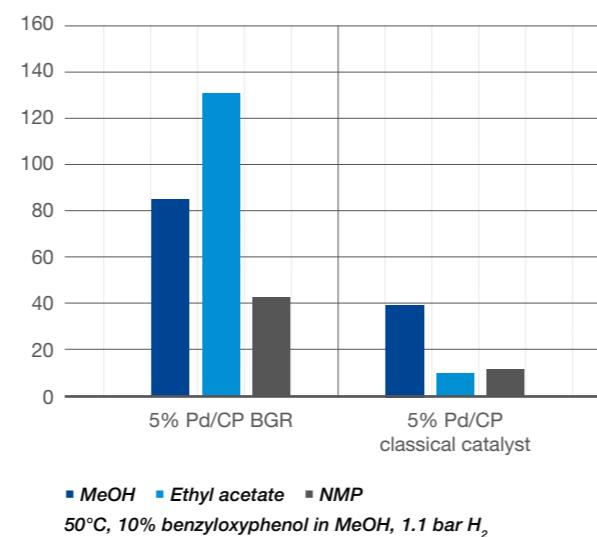
Blocking Group Removal Catalysts

One of the most widely used hydrogenation reactions in the pharmaceutical and fine chemical industry is removal of protecting groups. BASF developed a new series of precious metal-based catalysts called Blocking Group Removal (BGR) catalysts. These catalysts offer an intrinsically higher activity when compared to traditional catalysts (see graph 1), while maintaining good selectivity. In addition, BGR catalysts have proven effective in a much broader range of solvents while maintaining high activity and process productivity (see graph 2). As a result, BGR catalysts have been shown to out-perform classical catalysts in the selective removal of common blocking groups used in organic synthesis and removal of protecting groups used in peptides synthesis (FMOC, t-BOC). This broad applicability and robustness of our BGR catalysts, enables you to bring your products to the market faster. An important requirement of the fine chemical industry is to minimize the amount of metal used in the catalytic process, thus enhancing productivity. The higher activity of the new Blocking Group Removal catalysts outperforms classical catalysts at comparable metal loadings. This unprecedented characteristic, combined with a proven faster filtration time, translates into an increased productivity and robust

Graph 1. High Activity



Graph 2. Solvent Compatibility



process efficiency. To you, our customer, this means an overall cost saving, which makes you more competitive in the market. A sample kit containing our Blocking Group Removal catalysts is available through Strem Chemicals, Inc. on the web at www.strem.com/BASF. For commercial quantities please call one of the regional offices of BASF.

NanoSelect Technology

NanoSelect catalysts are characterized by unimodal metal particles on the nanometer scale. Reducing the size of metal particles to nanometer size:

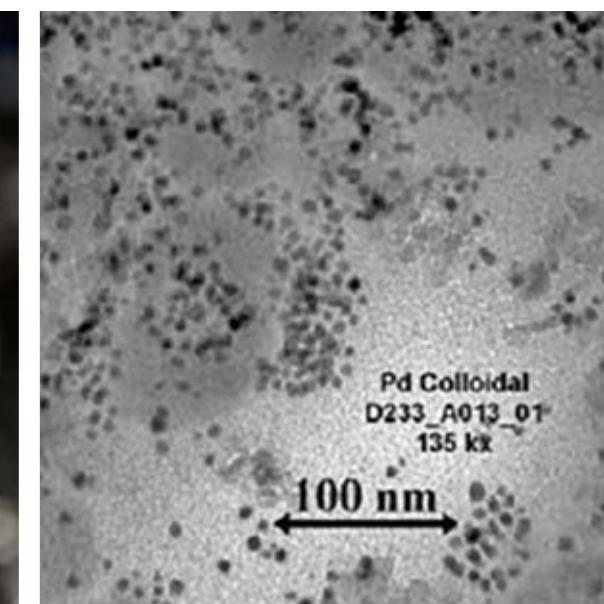
- Greatly increases the metal surface area available per gram.
- Boosts the catalytic activity.
- Demonstrates different catalytic behavior.

BASF used these basic principles to develop the innovative NanoSelect technology (patent WO2009096783). This technology utilizes a BASF reagent to combine reducing and stabilizing functions that produce highly unimodal, nano-sized metal colloids. These colloids can be deposited onto different support materials giving heterogeneous catalysts showing unique catalytic behaviors. In addition, NanoSelect catalysts typically need less metal while achieving good activity, thereby reducing the overall cost of usage of precious metal containing catalysts significantly.

NanoSelect technology has been used to develop several new Palladium and Platinum based catalysts with unique characteristics. One example is the Palladium catalyst LF-100 which can be used as a lead-free replacement for the classical Lindlar catalyst. In addition to the lead-free composition leading to more environmentally green processes, the 10-fold lower metal content is leading to drastic process cost reductions. Also various Platinum catalysts have been developed using the NanoSelect technology. For example Pt-110 and Pt-210 are very efficient Platinum catalysts for selective aromatic nitro group reduction. While keeping side reactions, like dehalogenation or carbonyl reduction, to a minimum these catalysts also minimize the formation and buildup of the hydroxylamine intermediate, thereby improving process safety.

The NanoSelect technology is continuously used for the development of new catalysts which will be made available to the market as soon as they become available.

Transmission electron microscopy (TEM) picture of NanoSelect Pd colloids.



Creating Value

What makes BASF's technologies and catalysts the clear choice for our customer? Value! BASF's value goes beyond that of others by offering better performance, a full portfolio of catalysts and adsorbers, superior product performance and a long-term commitment to the industry. Combined with our professional and attentive technical support team, BASF is the clear choice for all your catalytic process needs.

Challenge us with your needs!

For further information, please visit the web at www.bASF-catalysts.com or contact one of our experts.



Refining and Full Loop Service

BASF is the custodian of all precious metals contained in customer refining receipts and as such assumes the responsibility to maintain and operate:

- Controlled, segregated unit operations which minimize dispersion and loss of precious metals during the preparation and sampling of all receipts.
- Methods and procedures to generate a homogeneous concentrate from which a sample(s) representative of the entire bulk shipment can be drawn.
- Accurate and precise analytical methods and procedures to determine the precious metal content of the representative sample(s).
- Systems for the accurate and timely calculation and credit of metal settlement content in a seamless environment.
- Operation, technical and commercial organizations responsive to the problems, concerns and requirements of the customer.
- Complete and efficient capabilities under one roof to refine a wide range of precious metal spent materials within our ISO certified facilities.

Our “full loop” service provides a way to reduce total process cost by minimizing the cost of using and handling precious metals. It enables customers to reduce the cycle time of the metal, thereby assuring that most of the metal's time is spent in the application and not in non-value added services (i.e. transit or recovery) through implementation of optimal precious metal maintenance procedures (lease, buy, sell, fresh catalyst manufacturing, etc.). In addition, we offer full loop metals management, price risk management and reliable cost-effective raw material supply based on our unique understanding of market fundamentals, efficient refinery operations and salts / solutions manufacturing capabilities.

Depend on us to ensure that you have the precious metals critical to your products and processes when you need them, where you need them, in the right form at competitive market costs.

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About Us

BASF's Catalysts division is the world's leading supplier of environmental and process catalysts. The group offers exceptional expertise in the development of technologies that protect the air we breathe, produce the fuels that power our world and ensure efficient production of a wide variety of chemicals, plastics and other products, including advanced battery materials. By leveraging our industry-leading R&D platforms, passion for innovation and deep knowledge of precious and base metals, BASF's Catalysts division develops unique, proprietary solutions that drive customer success.

BASF – We create chemistry

NanoSelect is a trademark of BASF. Although all statements and information in this publication are believed to be accurate and reliable, they are presented gratis and for guidance only, and risks and liability for results obtained by use of the products or application of the suggestions described are assumed by the user. NO WARRANTIES OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE MADE REGARDING PRODUCTS DESCRIBED OR DESIGNS, DATA OR INFORMATION SET FORTH. Statements or suggestions concerning possible use of the products are made without representation or warranty that any such use is free of patent infringement and are not recommendations to infringe any patent. The user should not assume that toxicity data and safety measures are indicated or that other measures may not be required.

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