

# Make the right move with NanoSelect™ Catalysts

 **BASF**

The Chemical Company



# NanoSelect LF 100 and LF 200

## Environmentally friendly alternatives for highly selective hydrogenation processes

BASF proudly presents its NanoSelect™ technology platform, featuring NanoSelect LF 100 and NanoSelect LF 200 as the eco-friendly alternatives to classical Lindlar catalyzed hydrogenation processes. Lindlar catalysts are lead-modified heterogeneous palladium catalysts typically used in highly selective hydrogenation reactions. Unfortunately, the lead additive also causes Lindlar catalysts to face regulations that restrict their manufacture and use due to toxicity.

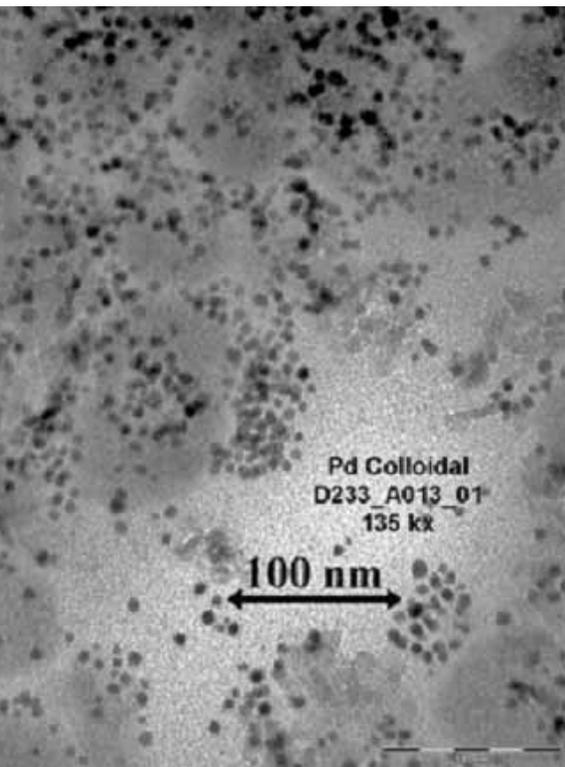
*Palladium-based NanoSelect LF 100 and LF 200 heterogeneous catalysts from BASF are lead-free, green alternatives to the classic Lindlar catalysts for highly selective hydrogenation reactions.*

## NanoSelect LF 100 and LF 200 catalysts are

characterized by unimodal metal particles on the nanometer scale. Nanotechnology is science and controlled engineering on the scale of nanometers (billionths of a meter). Reducing the size of metal particles to nanometers:

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

BASF Catalysts used these basic principles to develop an innovative, patented technology named NanoSelect. This technology utilizes a BASF reagent to combine reducing and stabilizing functions that produce highly unimodal, nanosized metal colloids (Figure 1). These colloids can be deposited onto different support materials giving heterogeneous catalysts with unique and surprising catalytic behaviors.



**Figure 1:** A Transition Electron Microscope photo of unsupported NanoSelect palladium-colloids.



*NanoSelect Technology for controlled flexibility is the proud recipient of the 2009 Frost & Sullivan North American Nanocatalysts Green Excellence of the Year Award*

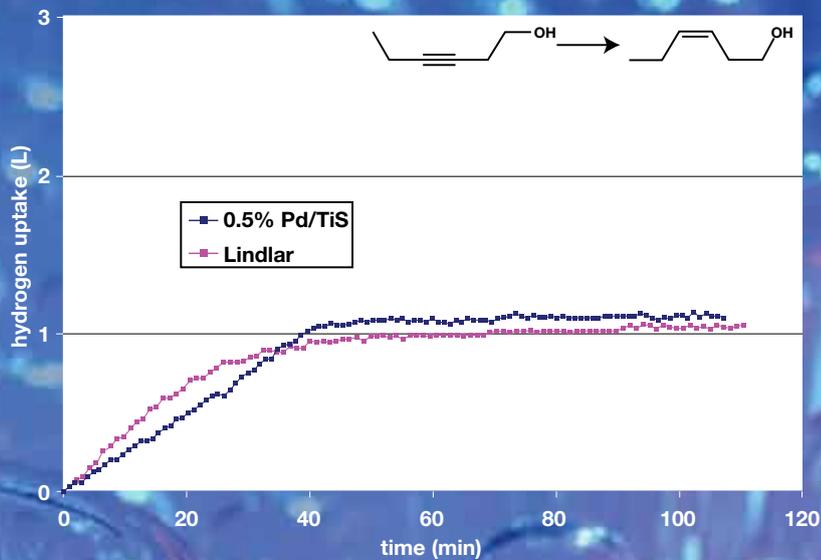


Figure 2: NanoSelect LF 200 versus Lindlar catalyst

## NanoSelect provides superior performance without lead and with less precious metal content

NanoSelect LF 100 and LF 200 catalysts are based on different supports and contain only 0.6 or 0.5 wt% of palladium, respectively. This differs greatly from Lindlar catalysts, which contain around 5 wt% palladium.

For example, when compared to the Lindlar catalysts in the selective hydrogenation of 3-hexyn-1-ol to the corresponding alkene (Figure 2), the NanoSelect LF 200 catalyst, with vastly less metal content and no lead content, exhibit similar activity and selectivity.

## NanoSelect LF 100 and LF 200 vs. Lindlar Catalysts

LF 100 and LF 200	Lindlar
Lead-free is environmentally friendly	Lead additives are toxic to the environment, and are heavily regulated in manufacture and use
Palladium content of 0.6 or 0.5 wt% greatly reduces process cost	Palladium content of 5 wt% significantly contributes to high process cost
High selectivity	High selectivity
Good activity	Good activity

*Based on 5% palladium content, \$900 is added to the total cost for every 1 kg of Lindlar catalyst used during hydrogenation.*

*With the palladium content reduced by a factor of ten, NanoSelect reduces the precious metal cost by an order of magnitude — resulting in a more economical process.*

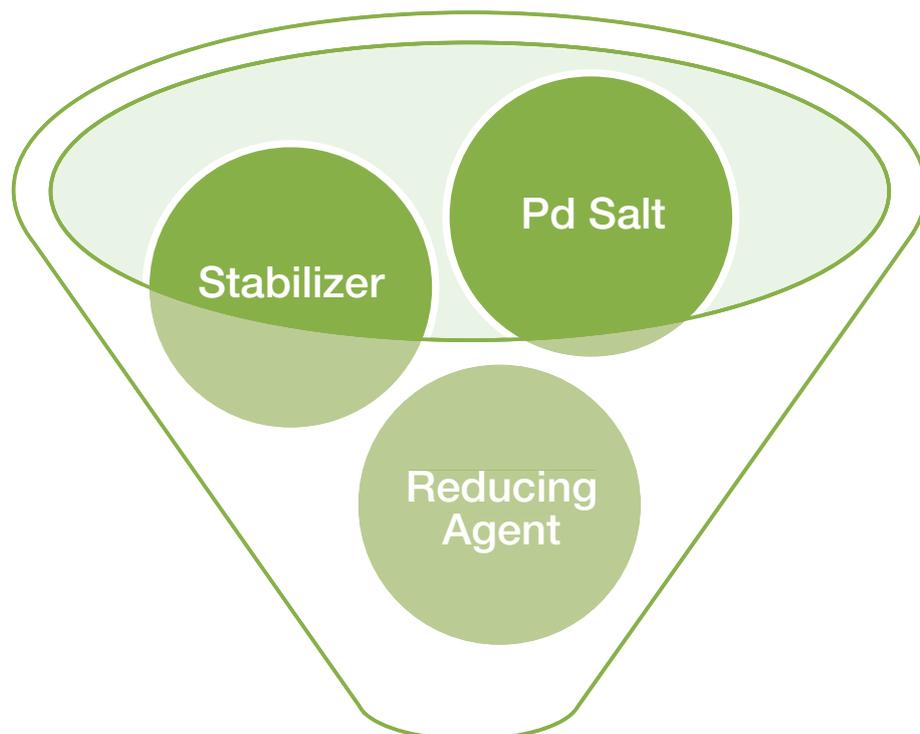
### Enabling efficient process economy and saving you money

When selecting a catalyst for a hydrogenation, the following factors must be considered:

- Catalyst productivity versus total cost of the process.
- Cost of the apparatus to maintain or apply a high pressure.
- High selectivity towards the desired product versus high process productivity.

NanoSelect LF 100 and LF 200 catalysts offer equivalent or greater hydrogenation activity to Lindlar catalyst (Figure 2) with no lead content and an order of magnitude less metal (0.5 wt% compared to 5 wt%). With less metal in the catalyst the cost of the process decreases significantly.

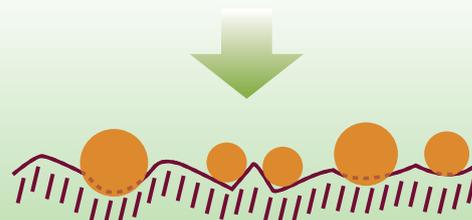
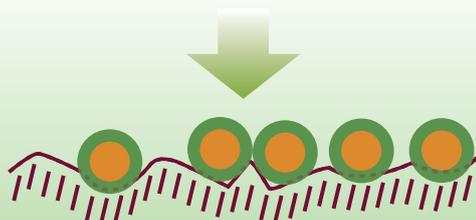
## Controlled Flexibility with NanoSelect Technology



**Pd core with protective organic shell**

## BASF NanoSelect vs. Other Commercial Catalysts

BASF NanoSelect	Other Commercial Catalyst
Narrow metal crystallite size distribution	Broad Metal Crystallite size distribution
Protective Organic Shell	Unprotected Metal Crystallites
Interaction between support and stabilizer	Interaction between support and metal
Large-scale Production	Large-scale Production





## Why BASF?

Our goal is to make our customers successful. This is accomplished by our constant passion for innovation, enabling enhanced economics, and increased productivity. In industry, we are a partner for the future with our extensive expertise of both catalysts and processes.



## Service

At BASF, we know that our success is dependent upon your success. That is why we are dedicated to offering intelligent system solutions, supported by our outstanding customer and technical assistance. An analysis of your current processes will reveal the BASF products and services that will greatly improve your efficiency and bottom line.



The Chemical Company

## 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. By leveraging our industry-leading R&D platforms, passion for innovation and deep knowledge of precious and base metals, BASF Catalysts develop unique, proprietary catalyst and adsorbent solutions that drive customer success.

## BASF - The Chemical Company



*NanoSelect Technology for controlled flexibility is the proud recipient of the 2009 Frost & Sullivan North American Nanocatalysts Green Excellence of the Year Award*

### BASF Catalyst Headquarters

BASF Catalysts LLC  
25 Middlesex/Essex Turnpike  
P.O. Box 0770  
Iselin, New Jersey 08830-0770 USA  
Tel: +1-732-205-5000  
Fax: +1-732-205-5687  
Email: [catalysts-america@basf.com](mailto:catalysts-america@basf.com)

### Americas

#### Americas Customer Care

BASF Catalysts LLC  
100 Campus Drive  
Florham Park, NJ 07932 USA  
Tel: +1-800-889-9845  
+1-973-245-7445  
Fax: +1-864-332-5087

### Asia Pacific

#### Asia Customer Care

BASF East Asia Regional Headquarters Ltd.  
45th Floor, Jardine House  
No. 1 Connaught Place,  
Central Hong Kong  
Tel: +852-2731-0191  
Fax: +852-2731-5634  
Email: [catalysts-asia@basf.com](mailto:catalysts-asia@basf.com)

### Europe, Middle East, Africa

#### BASF Worldwide Headquarters

BASF SE  
G-CCP, E100  
67056 Ludwigshafen, Germany  
Tel: +49-621-60-21153  
Fax: +49-621-60-43023  
Email: [catalysts-emea@basf.com](mailto:catalysts-emea@basf.com)

#### Europe Customer Care

BASF Italia Srl – Catalysts  
00131 Rome, Italy  
Tel: +39-06-41992605  
Fax: +39-06-41992338

[www.nanoselect.catalysts.basf.com](http://www.nanoselect.catalysts.basf.com)

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. © 2009 BASF