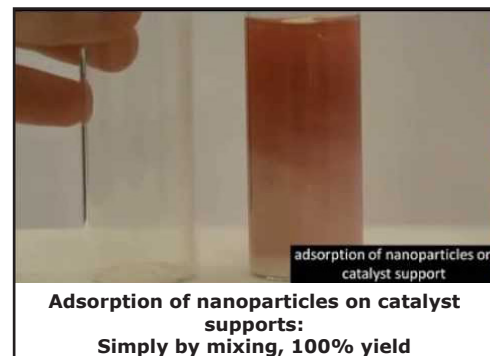
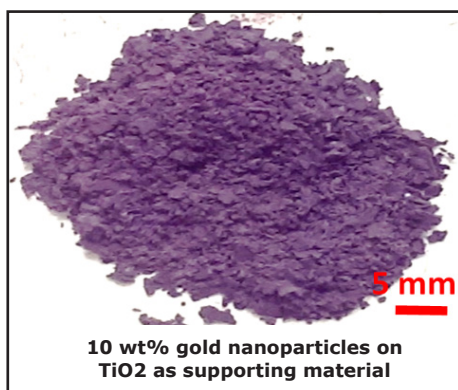


## What is Laser Ablation in Liquids?

Laser ablation is a physical process used to generate nanoparticle catalysts. It involves the use of short pulses of laser energy focused on a target in a solvent. The target absorbs the energy of the laser pulse and is vaporized (see product line "Reactant & Surfactant-free pure Nanoparticles via Laser Ablation"). The vaporized material then condenses as nanoparticles, ready to be supported (Real-Time video, see: [YouTube](#) or click on the picture on the upper right side).



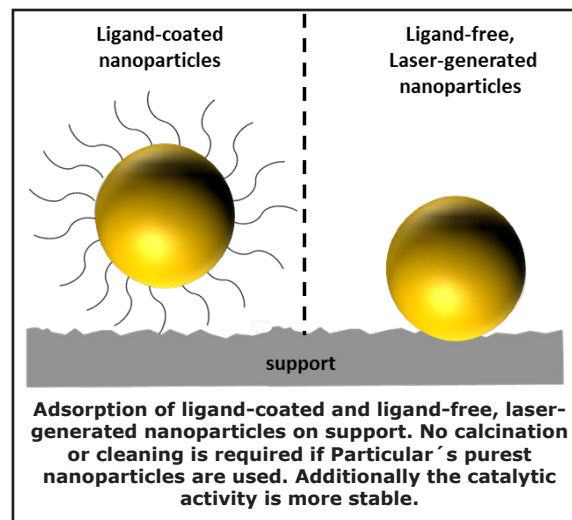
## Nano-active powder for catalysis and more?



Supported Laser-generated nanoparticles are powders with a high nano-activity. They are delivered as dry powders that can be stored for years without loss of quality. Laser fabrication leads to unusually high nanoparticle loads of up to 50 wt%, providing a high product functionality. Laser-generated nanoparticles for example consisting of gold, platinum, palladium, copper, or silver can be combined with a wide range of particulate supports like TiO<sub>2</sub>, BaSO<sub>4</sub> or carbon black providing a wide spectrum of different material combinations for different fields of applications like catalysis, pigmentation, or as nanofunctional polymer additives.

Adsorption efficiency is generally very sensitive to ligand concentration. In chemical synthesis residual ligands influence the adsorption of nanoparticles to supports negatively. The quantitative removal of the ligands is very challenging and accompanied by unwanted side effects like agglomeration. Particular's laser ablation makes it possible to generate ligand-free nanoparticles that show a 100 times higher adsorption efficiency under ambient conditions without pre or post-treatment of the educts and products.

The absence of ligands improves not only the affinity to carrier surfaces. As a result, no catalytic centers are blocked by ligands, the catalytic activity is significantly increased. That makes Laser-generated nanoparticles immobilized on particulate supports an efficient tool in heterogeneous catalysis.



## Advantages of supported laser-generated nanoparticles

- High nano-activity due to the unique properties of the laser-generated nanoparticles and high particle loads up to 30 wt% (even higher loads on request)
- Highest purity: free of residual chemicals
- No pre- or post-treatment of the educts and products necessary
- Many combinations of nanoparticle and support materials (more combinations on request)
- Combination of the unique properties of the laser-generated nanoparticles and the simple handling of the supporting powders

Visit [www.strem.com](http://www.strem.com) for new product information and a searchable catalog.

**Strem Chemicals, Inc.**  
7 Mulliken Way  
Newburyport, MA 01950  
U.S.A  
Tel: 978.499.1600  
Fax: 978.465.3104  
Email: [info@strem.com](mailto:info@strem.com)

**Strem Chemicals, Inc.**  
15, rue de l'Atome  
Zone Industrielle  
67800 BISCHHEIM France  
Tel: (33) 03 88 62 52 60  
Fax: (33) 03 88 62 26 81  
Email: [info.europe@strem.com](mailto:info.europe@strem.com)

**Strem Chemicals, Inc.**  
Postfach 1215  
77672 KEHL  
Germany  
Tel: 0 78 51/ 7 58 79  
Email: [info.europe@strem.com](mailto:info.europe@strem.com)

**Strem Chemicals UK Ltd.**  
An Independent Distributor of Strem Chemicals Products  
Newton Hall, Town Street  
Newton, Cambridge  
England CB22 7ZE  
Tel: 0845 643 7263  
Fax: 0845 643 7362  
Email: [enquiries@strem.co.uk](mailto:enquiries@strem.co.uk)

## Selection Matrix of laser-generated Nanoparticles and support powders

Strem offers a wide range of precious nanoparticles prepared via Laser Ablation in Liquid by Particular GmbH with high defect density adsorbed to powder supports with different mass loads:

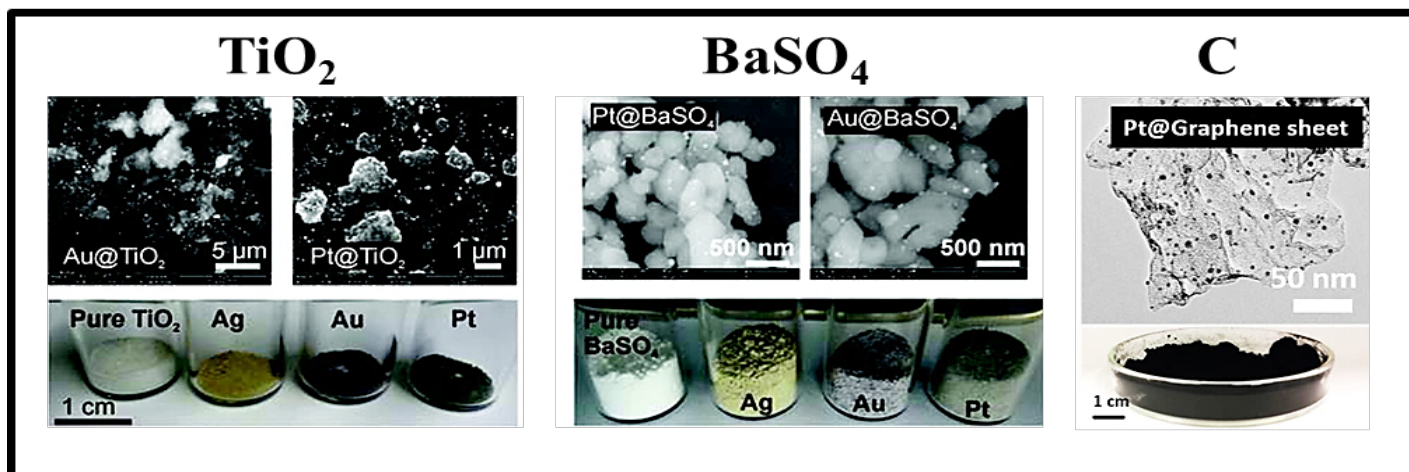
**Selection matrix: pick element, support material, mass load (• = available)**

Elements	TiO <sub>2</sub>					C				
	1 wt%	5 wt%	10 wt%	20 wt%	30 wt%	1 wt%	5 wt%	10 wt%	20 wt%	30 wt%
Au	•	•	•	•	•					
Pt						•	•	•	•	•

Supports are standard materials:

- TiO<sub>2</sub>: anatase - or rutil<sup>2</sup> -modification available
- C: Carbon Black, e.g., Vulcan

**Other combinations of support materials and elements on request!**



**Laser-generated nanoparticles (Silver, Gold, Platinum) on carrier materials (TiO<sub>2</sub>, BaSO<sub>4</sub>, graphene or Carbon black)**

<sup>1</sup> TiO<sub>2</sub>: Anatase (e.g., Hombicat Type II)

<sup>2</sup> TiO<sub>2</sub>: Rutil (e.g., P25)

Visit [www.strem.com](http://www.strem.com) for new product information and a searchable catalog.

**Strem Chemicals, Inc.**  
7 Mulliken Way  
Newburyport, MA 01950  
U.S.A  
Tel: 978.499.1600  
Fax: 978.465.3104  
Email: info@strem.com

**Strem Chemicals, Inc.**  
15, rue de l'Atome  
Zone Industrielle  
67800 BISCHHEIM France  
Tel: (33) 03 88 62 52 60  
Fax: (33) 03 88 62 26 81  
Email: info.europe@strem.com

**Strem Chemicals, Inc.**  
Postfach 1215  
77672 KEHL  
Germany  
Tel: 0 78 51/ 7 58 79  
Email: info.europe@strem.com

**Strem Chemicals UK Ltd.**  
An Independent Distributor of Strem Chemicals Products  
Newton Hall, Town Street  
Newton, Cambridge  
England CB22 7ZE  
Tel: 0845 643 7263  
Fax: 0845 643 7362  
Email: enquiries@strem.co.uk

Catalog #	Description
79-0921	Gold nanoparticles, 1% on carbon black (surfactant and reactant-free)
79-0916	Gold nanoparticles, 1% on Titania (anatase) (surfactant and reactant-free)
79-0905	Gold nanoparticles, 1% on Titania (anatase/rutile) (surfactant and reactant-free)
79-0926	Gold nanoparticles, 5% on carbon black (surfactant and reactant-free)
79-0935	Gold nanoparticles, 10% on Titania (anatase) (surfactant and reactant-free)
79-0930	Gold nanoparticles, 10% on Titania (anatase/rutile) (surfactant and reactant-free)
78-3015	Platinum nanoparticles, 1% on carbon black (surfactant and reactant-free)
78-3012	Platinum nanoparticles, 1% on Titania (anatase) (surfactant and reactant-free)
78-3005	Platinum nanoparticles, 1% on Titania (anatase/rutile) (surfactant and reactant-free)
78-3020	Platinum nanoparticles, 5% on carbon black (surfactant and reactant-free)
78-3030	Platinum nanoparticles, 10% on carbon black (surfactant and reactant-free)
78-3026	Platinum nanoparticles, 10% on Titania (anatase) (surfactant and reactant-free)
78-3023	Platinum nanoparticles, 10% on Titania (anatase/rutile) (surfactant and reactant-free)
78-3032	Platinum nanoparticles, 20% on carbon black (surfactant and reactant-free)
78-3035	Platinum nanoparticles, 30% on carbon black (surfactant and reactant-free)

## References:

### Catalyst fabrication:

- [1] Wagener, P.; Schwenke, A.; Barcikowski, S.: How Citrate Ligands Affect Nanoparticle Adsorption to Microparticle support. In: [Langmuir 28 \(2012\), pp. 6132-6140](#)
- [2] Marzun, G.; Streich, C.; Jendrzey S.; Barcikowski, S.; Wagener P.: Adsorption of Colloidal Platinum Nanoparticles to Supports: Charge Transfer and Effects of Electrostatic and Steric Interactions
- [3] Lau, M.; Haxhiaj I.; Wagener, P.; Intartaglia R.; Brandi F.; Nakamura J.; Barcikowski: Ligand-free gold atom clusters adsorbed on graphene nano sheets generated by oxidative laser fragmentation in water.
- [4] Marzun, G.; Nakamura J.; Zhang X.; Barcikowski S.; Wagener P.: Size control and supporting of palladium nanoparticles made by laser ablation in saline solution as a facile route to heterogenous catalysts.

### Catalyst or pigment/filler properties:

- [5] Lau, M.; Niemann, R. G.; Bartsch, M.; O'Neill W; Barcikowski S.: Near-field-enhanced, off-resonant laser sintering of semiconductor particles for additive manufacturing of dispersed Au-ZnO-micro/nano hybrid structures  
In: [Applied Physics A \(114\), pp. 1023-1030](#)
- [6] Gu, S.; Kaiser, J.; Marzun, G.; Ott, A.; Lu, Y.; Ballauf, M.; Zaccone, A.; Barcikowski, S.; Wagener, P.: Ligand-free Gold Nanoparticles as a Reference Material for Kinetic Modelling of Catalytic Reduction of 4-Nitrophenol  
In: [Catalysis Letter 145 \(2015\), pp. 1105-1112](#)
- [7] Schwenke, A.; Wagener, P.; Weiss, A.; Klimenta, K.; Wiegel, H.; Sajti, L.; Barcikowski, S.: Laser-Based Generation of Nanocomposites without Matrix-Coupling Agents for Bioactive Medical Devices. In: [Chemie Ingenieur Technik 85 \(2013\), Nr. 5, pp. 740-746](#)
- [8] Dong, W.; Reichenberger S.; Chu, S.; Weide P.; Ruland H.; Barcikowski S.; Wagener P.; Muhler M.: The effect of the Au loading on the liquid-phase aerobic oxidation of ethanol over Au/TiO<sub>2</sub> catalysts prepared by pulsed laser ablation. In: [Journal of Catalysis 330 \(2015\), pp. 497-506](#).
- [9] Youtube; Nanofunction; Photocatalytic Water Splitting Catalyst Fabrication by Nanoparticle Adsorption on Titanium Dioxide; 18.02.2014; <https://www.youtube.com/watch?v=o3wBcq4CbtI>

Visit [www.strem.com](http://www.strem.com) for new product information and a searchable catalog.

**Strem Chemicals, Inc.**  
7 Mulliken Way  
Newburyport, MA 01950  
U.S.A  
Tel: 978.499.1600  
Fax: 978.465.3104  
Email: [info@strem.com](mailto:info@strem.com)

**Strem Chemicals, Inc.**  
15, rue de l'Atome  
Zone Industrielle  
67800 BISCHHEIM France  
Tel: (33) 03 88 62 52 60  
Fax: (33) 03 88 62 26 81  
Email: [info.europe@strem.com](mailto:info.europe@strem.com)

**Strem Chemicals, Inc.**  
Postfach 1215  
77672 KEHL  
Germany  
Tel: 0 78 51/ 7 58 79  
Email: [info.europe@strem.com](mailto:info.europe@strem.com)

**Strem Chemicals UK Ltd.**  
An Independent Distributor of Strem Chemicals Products  
Newton Hall, Town Street  
Newton, Cambridge  
England CB22 7ZE  
Tel: 0845 643 7263  
Fax: 0845 643 7362  
Email: [enquiries@strem.co.uk](mailto:enquiries@strem.co.uk)