Examples of applied nanotechnology

Protective sol-gel nanocoatings for enhanced surface properties

The sol-gel technique involves the evolution of organic nanoscale networks in a continuous liquid phase through the formation of colloidal suspension and the following gelation of the sol. A wide range of materials can be coated with sol-gel technique. Substrate material can be metallic, ceramic, polymeric or even organic materials like wood, paper and fibres. By adding nanoparticles to the sol-gel coatings abrasion resistance can be improved, surface topography can be modified and photoactive surface properties can be achieved.

Nanopatterning

Nanoimprint litography has several different approaches based on mechanical embossing. It is foreseen as a versatile, fast and economical way to fabricate nanoscale structures for optics, photonics, nano- and polymer electronics etc. VTT has been developing two approaches for nano-patterning, the step and stamp imprint lithography (SSIL) with high accuracy and versatility and roll to roll nano-imprint technique for high volume manufacturing of nanostructures. With the collaboration of SUSS Microtech the method has been developed into a stage where a dedicated commercial device, NPS300, is available for both research and industrial use.

ALD for MEMS manufacturing

Microelectromechanical systems (MEMS) are designed and manufactured at VTT for various sensing and actuation purposes in co-operation with domestic and international partners. Implementation of atomic layer deposition (ALD) processes in MEMS manufacturing expands the processing capabilities beyond those of conventional integrated circuit processing, enabling for example low-temperature pinholefree insulators and conformal nanometerrange coatings inside 3D structures.

Semiconductor nanotechnology

The feature sizes in semiconductor microelectronics have already been scaled down into the nanometer range and nanotehnology is present in everyday electronics. Besides the simple reduction of the component size, nanotehnology allows to utilize quantum effects, which creates new device functions and applications. VTT's class 10 cleanroom at Micronova, is dedicated for small scale production, process development and research, thus providing an excellent environment for nanotechnology research and prototyping in various areas of nanoelectronics and nanophotonics.

Additional information

Asko Ojala
Key Account Manager
Tel. +358 (0)20 722 3024
asko.ojala@vtt.fi

Jouni Ahopelto
Research Professor
Tel. + 358 (0)20 722 6644
jouni.ahopelto@vtt.fi

Mika Paajanen
Principal Scientist
Tel. + 358 (0)20 722 3316
mika.paajanen@vtt.fi

02012012 SM

Applied nanotechnology for industrial benefits

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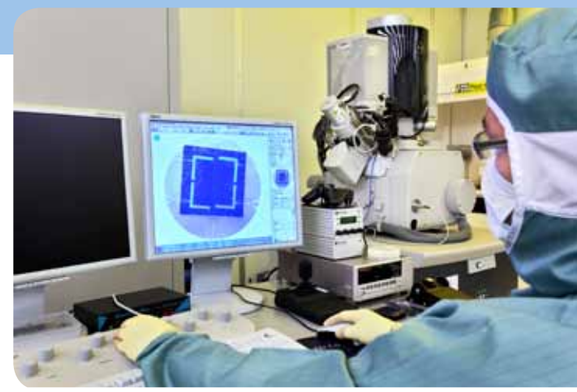


Applying latest nanotechnology know-how to the development of nanoscience, materials and production methods keeps the industry and research at a competitive performance level. At VTT the nanotechnology is applied strongly in electronics, in printable intelligence, in biomaterials and in functional materials and surfaces.

NanoSCIENCE

Understanding of the basic principles in nanotechnology as well as new scientific innovations can be used for the advancement of the whole nanotechnology research area and innovation chain. One of the typical nanotechnology related benefits arises from the large surface area of the nanopowders and particles. This also creates huge challenges when trying to deal with the nanoparticles in a controllably way. The nanoparticles also offer a chance for self-assembly, which enables the formation of designed molecule-thick layered structures. Melting point and colour are additional physical properties that are strongly related to the size of the nanoscale particles. The nanoparticles also have interesting diffusion properties, which enables them to move through barriers and transfer functionalities attached to them. The health and safety issues are in essential role when dealing with nanomaterials, which VTT recognizes by participating in multinational nanosafe projects.

Nanomaterials

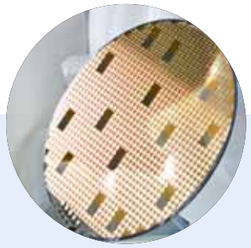
Typically nanomaterials contain some constituent that has particles in nanosize. The nanosized constituents can affect e.g. to the material's optical, thermal, electrical, magnetic and mechanical properties. Both bulk and surface properties can be strongly affected by nanomodification. VTT has tailored methods to process nanoparticles into various nanocomposites. The functionalization of the nanoparticles and the adjustment of the process parameters play an important role. Often the only imaginable way to further improve the desired material property is to use the potential that nanomaterials have to offer.

Production methods

The processing and manufacturing of products with nanotechnology requires sophisticated production equipment. E.g. SSIL nanoimprint production equipment at VTT can manufacture geometries in the nanolevel and roll to roll production methods can be used for broadening the method for massproduction. Nanopowders can be functionalized, compounded and extruded to reach large production volumes. Although the nanophenomena are usually first studied in small scale laboratory experiments the aim in most cases is to develop high-volume production methods.

Nanoimprint and stamp manufacture

-Nanoimprint lithography tool NPS300
-roll to roll nanoimprinting
-e-beam lithography

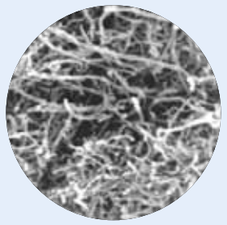


Nanocomposite hybrid coatings

- sol-gel synthesis
- spincoating
- thermal spray coating
- roll to roll spray coating line
- contact angle measurements

Plastic nanocompounds

- functionalization of nanoparticles
- compounding and extrusion in clean room
- filmmaking (sheet stretching)



ALD processing for MEMS applications

- SUNALE^{TM} R-150 ALD reactor
- patterning by photolithography
- nanopattering by e-beam and nanoimprint lithography
- AFM and SEM characterization