



# NANOPARTICLES FOR DIAGNOSTICS AND THERAPEUTICS

By altering materials, size, shape of nanoparticles and by surface functionalization, tailor-made tools can be made to specifically probe cellular and sub-cellular processes in-vivo and in-vitro paving the way to new diagnostics and therapeutics.

## APPLICATION FIELDS

- ▶ Molecular diagnostics and imaging with nanoparticles;
- ▶ Nanomedicine: the application of nanotechnology in medicine.

## POTENTIAL PARTNERS

We are the nanotechnology partner of choice for biomedical partners with little experience in nanotechnology and nanofabrication but with large biomedical R&D and biomedical application knowledge:

- ▶ Pharmaceutical and diagnostic companies;
- ▶ Biomedical research and imaging labs.

## ACTIVITIES

- ▶ Modelling and design of nanoparticles;
- ▶ Synthesis of metal, oxide and magnetic nanoparticles;
- ▶ Nanoparticle bio-functionalization;
- ▶ Nanoparticles for theranostic applications.

## SCOPE

Diseases start on micrometer and sub nanometer scales; at the cellular and biomolecular level. Nanotechnology's ability to interact and shape matter on the scale of biomolecules is opening the door to a new generation of improved diagnostics and therapies that detect or tackle a number of physiological disorders at a fundamental level. Inorganic (bio) functionalized nanoparticles have emerged as very promising biomedical agents since their size approaches those of biological entities such as viruses, proteins or DNA. Therefore biocompatible nanosized particles are promising as potential multifunctional tools for various in-vivo and in-vitro biomedical applications including magnetic separation, purification and concentration, biosensing, diagnostics, imaging, and therapeutics.

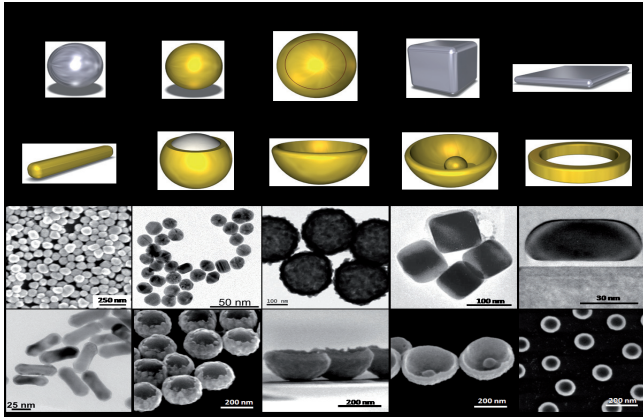
## ACTIVITIES

### ▶ MODELLING AND DESIGN OF NANOPARTICLES

Application-specific nanoparticles are tailored to the specifications and requirements of the desired application. Imec holds the required expertise and infrastructure required to design nanoparticles by varying material, size, geometry and composition according to the target application. The physical, be it optical or magnetic, properties of the designed particles are precisely modelled and optimized accordingly.

### ▶ SYNTHESIS OF METAL, OXIDE AND MAGNETIC NANOPARTICLES

At imec, we focus on the development of various strategies for the realization of metal, oxide and hybrid nanoparticles with improved physicochemical properties. Well-defined methodologies for the synthesis of noble metal (e.g. Au, Ag), magnetic (e.g.  $\text{Fe}_3\text{O}_4$ ,  $\text{CoFe}_2\text{O}_4$ , Co, FePt), silica ( $\text{SiO}_2$ ) nanoparticles and 2D arrays of such particles have been established. Imec particles are monodisperse and tunable in size, shape and composition.



01 (Top) Schematic illustration of various shapes of plasmonic nanostructures and (bottom) the corresponding electron microscopy images.



02 Suspended noble metal and metal oxide nanoparticles of various sizes and morphologies.

## MORE INFORMATION

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### ► NANOPARTICLE BIO-FUNCTIONALIZATION

Imec focuses on the surface functionalization required to render the nanoparticles stable, water soluble and biocompatible. Besides that the coupling of ligands i.e. proteins, peptides, antibodies and other vectors will significantly influence the interaction with cells and receptors on the cell membrane. For some applications uptake of nanoparticles by cells is desirable. For instance in the case of the use of nanoparticles in intracellular proteome analysis or stem cell tracking, the coating is crucial and will significantly affect the nanoparticle uptake.

### ► NANOPARTICLES FOR THERANOSTIC APPLICATIONS

In-vivo diagnostic and therapeutic methods can benefit highly from new developments in nanoparticle research. Imec synthesizes and develops nanoparticles with properties tuned to specific application fields.

#### ► Diagnostics:

In the context of diagnostics, imec exploits the physicochemical properties inherent to nanoparticles to increase the sensitivity and specificity of diagnostics.

The magnetic properties of magnetic beads developed in imec are exploited for the isolation and detection of target biological entities to increase measurement of local concentrations and thus improve sensitivity. The beads are rendered target-specific through surface functionalization and used

as a label which can be manipulated through magnetic fields and detected by magnetic sensors.

The optical properties of gold nanoparticles are exploited to create locally enhanced detection fields. Gold nanoparticles are synthesized and functionalized with specific probes, the properties of the nanoparticles are tuned to locally enhance excitation fields induced by incident light (surface plasmons), thereby increasing the detection limit of biological entities.

Imec is further investigating magnetic nanoparticle crystals with physicochemical properties tailored for uptake by cells and in-vivo diagnostic, MR imaging and cell tracking.

#### ► Treatment:

Another application actively explored by imec is particle-mediated hyperthermia cancer therapy. This is a form of cancer treatment that uses an elevated temperature to kill the tumor tissue, where the heat is not only generated but also specifically targeted to the tumor by the nanoparticles. Imec synthesizes core shell structured engineered nanoparticles with absorption wavelength in the near-infrared (NIR) region. The NIR region of the spectrum provides maximal penetration of light through the body due to relatively lower scattering and absorption from the intrinsic tissue chromophores. The heat generation properties of the synthesized particles are studied as well as the cellular uptake of the particles in vitro.

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