

List of technologies

1 Manufacturing of Nano-Materials

1.1 Nanophased particles production & functionalization

- 1.1.1 New methods for energy efficient production methods (laser or ultrasonic assisted mixing methods, high pressure or high energy mixing systems.....
- 1.1.2 Solid State
- 1.1.3 Vapour Methods, Vapour phase reactions
- 1.1.4 Scalable processes
- 1.1.5 Chemical Methods
- 1.1.6 High energy irradiation
- 1.1.7 Gasphases synthesis
- 1.1.8 Sol - Gel processes
- 1.1.9 Biogenesis
- 1.1.10 Laser pyrolysis, laser transfer processing, laser irradiation
- 1.1.11 Microemulsions (e.g. study of surfactants and related methods for avoiding formations of undesired colloids or favouring an anisotropic growth of particles)
- 1.1.12 Milling, Drying
- 1.1.13 Hydrothermal processes
- 1.1.14 Ultrasound and microwave reactors
- 1.1.15 chemical precipitation
- 1.1.16 Supercritical Process (CO₂ and others)
- 1.1.17 Templates (selforganization in electrochemistry and other processes)
- 1.1.18 Ultrasound and Microwave Reactors
- 1.1.19 High temperature processes, including
 - Fluidized bed reactions
 - Laser ablation
 - Arc discharge

1.2 Bulk integration

- 1.2.1 Methods and equipment for purification, separation, drying, re-disperse and handle nanoparticles
- 1.2.2 Methods and equipment for purification, separation, drying, re-disperse and handling of nanoparticles
- 1.2.3 Online quality control of nanomaterials, nanosurfaces and devices (differentiating from functional testing) applicable in current micro and macro production technologies

1.3 Nanophased particles production & functionalization - bulk integration

- 1.3.1 Functionalization of Nanoparticles
 - 1.3.1.1 Investigation on properties of high resistance steels
- 1.3.2 Characterization of Nanoparticles
- 1.3.3 Flexible and modular systems
- 1.3.4 Design of molecular components

- 1.3.5 Development of tools with molecular structures in order to build up new structures with new functionalities
- 1.3.6 Steps of manufacturing to fix properties and relations of the molecules and self-proceed
- 1.3.7 Molecular nanotechnologies, molecular engineering (join molecules to complex structures by self organizing, molecular assembling)
- 1.3.8 Self assembling of bio-molecules on nanostructures, and only there)
- 1.3.9 Standards
 - 1.3..9.1 pressing, spraying and deposition of Nanoparticles
 - 1.3..9.2 Coating
 - 1.3..9.3 Chemical Modification
 - 1.3..9.4 Photochemistry
 - 1.3..9.5 2D/3D structuring
 - 1.3..9.6 Mechanical reinforcement
 - 1.3..9.7 Energy storage
 - 1.3..9.8 enhance thermal and electrical proprieties
 - 1.3..9.9 enhance mechanical properties of materials (strength, stiffness, hardness, decrease of weight)
- 1.3.10 Standardisation
 - 1.3..10.1 Avoidance of the build up of tolerances in assembly
 - 1.3..10.2 tools to enable lower investment and higher reliability, higher complexity and increased precision of products and processes
 - 1.3..10.3 reduction in component size by orders of magnitude
 - 1.3..10.4 Control systems focused on closed loop processes.
- 1.3.11 Quality control
 - 1.3..11.1 Scanning Probe Induced Oxidation
 - 1.3..11.2 Scanning Probe Resist Exposure
 - 1.3..11.3 Dip-Pen Nanolithography
 - 1.3..11.4 Scanning Probe Mechanical Machining
 - 1.3..11.5 Stereolithography
- 1.3.12 Nano-Stereolithography

1.4 Nanoproducts

- 1.4.1 Nanowires
- 1.4.2 Carbon nanotubes
- 1.4.3 Organic Electronics
- 1.4.4 Organic LEDs
- 1.4.5 Printed Electronics
- 1.4.6 Polymers
- 1.4.7 Dendrimers
- 1.4.8 Development of new materials (organic, inorganic hybrids, biomaterials, CNT based materials)
- 1.4.9 Development of nanotubes and nanowires
- 1.4.10 Development of fullerene-like structures
- 1.4.11 Development of nanodots, dendrimers, biomolecules-nanoparticles hybrid systems,etc)
- 1.4.12 Development of multifunctional nanomaterials
- 1.4.13 Development of complex structures designed to perform multiple tasks (for example materials that recognize, detect and catalyze the destruction of toxic molecules (environmental toxics including air pollutants, chemical threats, etc.).

- 1.4.14 Development of Active materials, active structural elements and hybrid materials which are electroactive, or chemomechanically active, multiferroic, composite multiferroics, etc)
 - 1.4.15 nanoreservoirs and nanoreactors (i.e. nanostructured materials for Hydrogen storage)
 - 1.4.16 Composite, materials with form memory,
 - 1.4.17 Development of dielectric, semiconductor, and/or conductor. Materiskl
 - 1.4.18 Nano-taylored properties- best potential for ultra-low friction, controlled electrical properties, controlled optical properties, product monitoring
 - 1.4.19 On-line microsensors for web-based macroproduction global monitoring
- 1.5 Safety and security
- 1.5.1 Environmental friendly production processes and equipment (1)
 - 1.5.2 Safe handling of nanomaterials during production and transport (1)
 - 1.5.3 Security aspects (e.g. security marks, etc.)
 - 1.5.4 Integrated quality control methods (e.g. thermography, interferometry, 3D imaging with atomic accuracy, etc.) (3- 1 for thermography interferometry)
 - 1.5.5 How to assure the overall function, especially if several regions, molecules, cells (biological or also structural) are acting different or failing

2 Manufacturing of NanoSurfaces

2.1 Nano-coating (e.g. composite nanocoatings in automobile production)

- 2.1.1 Metrology of complex surfaces (freeform surfaces and/or micro structured surfaces)
- 2.1.2 Nanoindentation and FEM supported evaluation of coatings stress-strain and hardness

2.2 Nanocoatings over extense areas

- 2.2.1 Micro- and nanostructuring (surfaces and 2.5 till 3D structuring)

2.3 Advanced and new technologies for 2D, 2.5 and 3D fast and cost-effective nanopatterning over large surface areas.

- 2.3.1 High production rate/low cost nm structures for larger surfaces > 100 mm.)
- 2.3.2 Photolithograpy (including extrem UV / etching
- 2.3.3 Electron and ion projection lithography, AFM lithography, Interference Lithography, nanosphere lithography, soft lithography)
- 2.3.4 Other Lithography methods (e-beam, nano x-ray and ion beam)
- 2.3.5 Laser structuring/laser direct patterning/ (laser beam interference lithography)
- 2.3.6 EDM, -electromachining and electric-spark technology
- 2.3.7 Microcontactprinting / micro- and nanoimprint
- 2.3.8 Use of biological self-assembled layer as mask (S-layer technique)
- 2.3.9 Dynamic Shadow mask technique for 3D shapes
- 2.3.10 3D processeS
- 2.3.11 Nano electro-chemical structuring
- 2.3.12 Multi-axes machining (e.g. raster milling)
- 2.3.13 Precision machining of steel/difficult-to-machine materials

- 2.3.14 Deterministic (micro) grinding and deterministic polishing
- 2.3.15 Hybrid processes
- 2.3.16 Spindle technology
- 2.3.17 Cutting tools
- 2.3.18 electrochemical deposition
- 2.3.19 Thin film
- 2.3.20 PVD, CVD, PECVD, PLD
- Sputter deposition
- Molecular Beam Epitaxy
- Spin, spray coating, printing
- 2.3.21 atomic layer deposition
- electroplating
- 2.3.22 chemical bath deposition
- 2.3.23 self assembled molecular films
- 2.3.24 Langmuir Blodgett films/ (Langmuir Blodgett) Self Assembly
- 2.3.25 Nanostructures separated from wood-based and others materials
- 2.3.26 Thick coating
- 2.3.27 Laser based thermal spraying
- Laser based cold spraying
- 2.3.28 Deposition (uniform, nano-meter)
- 2.3.29 Self assembly (nano-porous)
- 2.3.30 High energy irradiation
- 2.3.31 Surface Modification
- 2.3.32 Chemical grafting
- 2.3.33 Cleaning technologies
- 2.3.34 Oxidation
- 2.3.35 Passivation
- 2.3.36 Ion Implanting
- 2.3.37 corona conditioning
- 2.3.38 flammings
- 2.3.39 Planarisation of silicon wafers, including coated wafers
- 2.3.40 Wafer thinning
- 2.3.41 Biological self assembled molecules deposition
- 2.3.42 Laser direct synthesis
- 2.3.43 Annealing / Recrystallisation
- 2.3.44 Laser based surface treatment
- 2.3.45 Gas plasma surface treatment used to modify on a microscopic level the surface of polymers, ceramics and metals as well as textiles
- 2.3.46 Laser ablation
- 2.3.47 Processing and synthesis with cluster ion beams
- 2.3.48 Plasma immersion ion implantation for surface modification and surface coating

3 Manufacturing Micro Components.

3.1 Technologies for (micro/nano) components and devices

- 3.1.1 Micro fiber glass technology for MEMS (f-MEMS) - 3D Technology.

3.2 Volume production processes

- 3.2.1 Injection molding

- 3.2.2 LiGA
- 3.2.3 Hot embossing
- 3.2.4 Fiber optics (f-MEMS) processes
- 3.2.5 Libraries with standard circuits and designs for microsystems

3.3 Assembly and integration processes

- 3.3.1 Replication methods / forming processes for smaller size - 10 nm structure diameter 150 nm with higher aspect ratio, higher flexibility in material choice and more complex structures)

3.4 sintering (nano-powders,...)

3.5 micro- and nanoforming

3.6 Epitaxy on Patterned Substrates

4 Micro- and Nano Manufacturing Systems and Platforms

4.1 Knowledge based fabrication

- 4.1.1 Multi-scale simulation
- 4.1.2 Design and simulation
- 4.1.3 Tools for test, metrology and characterization)
- 4.1.4 Characterization by SEM, TEM EDX, SAXS, FIB, AFM, , EELS, Micro-Raman
- 4.1.5 Scanning probe measurement (AFM) (topography, electrical, tribology probing, etc.)
- 4.1.6 Optical techniques (image processing, microscopy, thermography, etc.)
- 4.1.7 Parallelisation of test concepts, especially the raster sensor techniques or test techniques from the biology area like the patch-clamping
- 4.1.8 Electrical/optical Measurement of reactions at the surface of nanostructures

4.2 Development and implementation of scalable, intelligent and modular meso-, micro- and nanomanufacturing systems

- 4.2.1 New generation of software design packages with higher resolution for nanofeatures for manufacturing, covering both lithography and (nano) manufacturing in integrated format.
- 4.2.2 Design for manufacturing, assembly and test; new design tools for improvement of quality and reliability; Virtual prototyping;
- 4.2.3 Finite element implementation of multi scaled models, coupled simulation

4.3 Reconfigurable Scalable and Intelligent Micro- And Nanomanufacturing Platforms and Systems

4.4 Integrated platforms

- 4.4.1 Multi scaled models of multifunctional materials, micromechanics-based models, phenomenological macro scale modelling, molecular mechanics of active nanomaterials

- 4.4.2 Further Evolution of methods and algorithms for nano scale mechanisms design by means of determine combination of molecules and nano parts

4.5 Development from lab scale to industrial applications

- 4.5.1 Step Growth Methods
- 4.5.2 Self assembly
- 4.5.3 Strain induced physical and/or Chemical and/or biological Self Assembly
- 4.5.4 Template Assisted Self Assembly
- 4.5.5 Services for microsystems testing

5 Assembly and Integration of Multi-Functional Micro-Nano Devices (topics to be integrated under previous areas)

5.1 Assembly and integration, design, control and test

- 5.1.1 Electrical and mechanical integration
- 5.1.2 Alternative methods (e.g. direct integration, combined integration approaches)
- 5.1.3 Packaging
- 5.1.4 Novel processes for integration of nano and micro structures, e.g. nano structures in a micro channel and nano devices in connection with the macro world (e.g. photonic crystals in connection with fibreglass and laser)
- 5.1.5 Micromechatronics integration
- 5.1.6 Integration of SW and HW tools, including smart functional materials, towards the development of Micro-factory
- 5.1.7 Network based interface hardware and software for flexible and modular fabrication network.
- 5.1.8 Robotics, automation and control
- 5.1.9 Adaptive and intelligent mobile robots with integrated micro and nano technological sensory systems.
- 5.1.10 swarm robotics
- 5.1.11 miniaturization of actuators, smart actuators, nanoactuators, integration of micro- and nanoactuators
- 5.1.12 Intelligent control (ANN, fuzzy, neurofuzzy, genetic algorithms, self-learning approaches, decision making systems, expert systems, bio-inspired algorithms...)
- 5.1.13 Miniaturisation of sensors, new methods to integrate them into existing (macro) machines for on-line control of process parameters
- 5.1.14 macro and miniature mobile systems with micro controllers miniaturized mobile robots
- 5.1.15 micro-nano sensory fusion for macro robotics
- 5.1.16 macro diagnostic (monitoring) systems with distributed microsensors
- 5.1.17 nanostructure suspension for macro rubbing pairs for friction decreasing.
- 5.1.18 “smart actuators”. Integration of sensing and control directly into actuators#
- 5.1.19 miniaturization of power sources for autonomous robots
- 5.1.20 new forms of bio-inspired climbing and walking motion
- 5.1.21 new man-machine interfaces: new input devices (haptic and tactile)
- 5.1.22 standard mechatronic interfaces
- 5.1.23 Flexible automated repair lines

5.2 Micro- and nano handling

- 5.2.1 Micro- and nanogrippers
- 5.2.2 Micro- and nanohandling robots
- 5.2.3 Special handling methods with intelligent control (e.g. avoiding sticking effects, guaranteeing precise release and positioning etc of nanocomponents)
- 5.2.4 Special sensoris for feedback (vision, force, position...)
- 5.2.5 Non contact manipulation processes
- 5.2.6 Macro robotic grippers with micro

5.3 Micro- and nanoassembly

- 5.3.1 Combined self-assembly techniques
- 5.3.2 Joining methods (laser welding, high density TIG welding, friction stir welding, resistance, gluing, bonding...)
- 5.3.3 Robotic nanoassembly

5.4 Integration

- 5.4.1 Integration of standard manufacturing processes with micro- and nanostructured materials
- 5.4.2 Fully automated equipment with expert systems for production of special Nanoproducts in fast and flexible upscaling quantities and enabling fast change of products without a complex change of production parameters, (1-upscaling)
- 5.4.3 Nano applications in life-science (lab-on-chip systems)
- 5.4.4 Enhancement of production processes and machines by integrated micro- and nanotechnologies (e.g. motors with nano suspension for reduced friction providing higher durability, endurance limits, reliability increasing and supply energy decreasing.
- 5.4.5 Integration of MST/NST sensoric and actuation devices with monitoring, self-learning adaptive process control
- 5.4.6 Combined production process to merge on one chip functions of various technologies, (e.g. detection and information processing, enabling integration and production of artificial vision system,
- 5.4.7 Photon components on the base of nanostructures for new types of telecommunications, robotics and monitoring.
- 5.4.8 Combined production process for manufacturing of biotechnological, medical and pharmaceutical processes, e.g tissue. Engineering (artificial organs, new skin, implants, pharmaceuticals, etc.)
- 5.4.9 Control systems focused on closed loop processes.
- 5.4.10 manufacturing lines with low investment (e.g. micro-/nano desktop factories) with flexibility and low risk of failure.