Role of research and technology in the Nanofutures Roadmap

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Description of Working Group Research and Technology

- Chair: Udo Gommel (Fraunhofer IPA, Germany)
- Co-chair: Bertrand Fillon (CEA-Liten)

- Registered members at nanofutures webportal: 339 members
  - European Commission/Ministry: 3,2 %
  - Network: 16,3 %
  - Industry: 22,7 %
  - Research: 56,8 %

WG Aims and Strategies

The activity of this WG is aimed at focusing **European strategic efforts on key aspects** related to nano research and technology.

For all key issues, it is necessary to work on

- **roadmaps, vision papers, SRAs,**
- SOPs,
- **trends (technological & scientific),**
- **action plans,**
- etc.

for supplying and establishing accessible instruments.

Interactions with stakeholders, CSAs and other initiatives

- Strong **Research and Technology Centers** as backbone:
  CEA, TNO, Fraunhofer Alliance Nanotechnology, Sabanci University Nanotechnology Research and Application Center, CERTH, Institute of Nanotechnology, CeNIDE, Tekniker
  → to respond to different enabling technologies, pointed to **global leader companies** (e.g. TWI Ltd., Umicore, Numonyx, ...)

- **Drivers, barriers, and technical capabilities for developing nano products**
  → ***NanoCom* (Acciona) , *ProNano, NanoDevice***

- Use interaction: Roadmap/Survey , nano relevant **Technological Hot Spots** → **EUMINAfab**

- **Close Interaction** with well established **platforms**, e.g.:
  MINAM → up-dating of the Strategic Research Agenda, Roadmap
  and Manufuture (**TNO**) → multi-annual plan

- **Direct Link** to Nanocentral (Nanomaterials2012→ **Innovnano**
- **Direct Talks** to BASF, Microelectronica, Bischoff & Klein, ESA, NASA, Steinbeis, Nanotechnology Industry Association NIA, Spinverse

WG Contributions to NANO*futures*
Deliverables and Tasks

Individial steps and contributions

- D 1.1(→ M3):
  Detailed description of the WGs knowledge area of interest, application fields, expected benefits and impact, risks involved, main international actors, etc.

- D1.3 (→ M8): **Members Input**
  Analysis of recent and on-going EU projects, identifying on common research lines
  => classification of R&D priorities and innovation needs

- D2.2 (→ M9): **Members Input**
  Identification of nanotechnology key nodes
  → up to 5 relevant horizontal issues

WG Contributions to NANO*futures*
Deliverables and Tasks

Individial steps and contributions desired

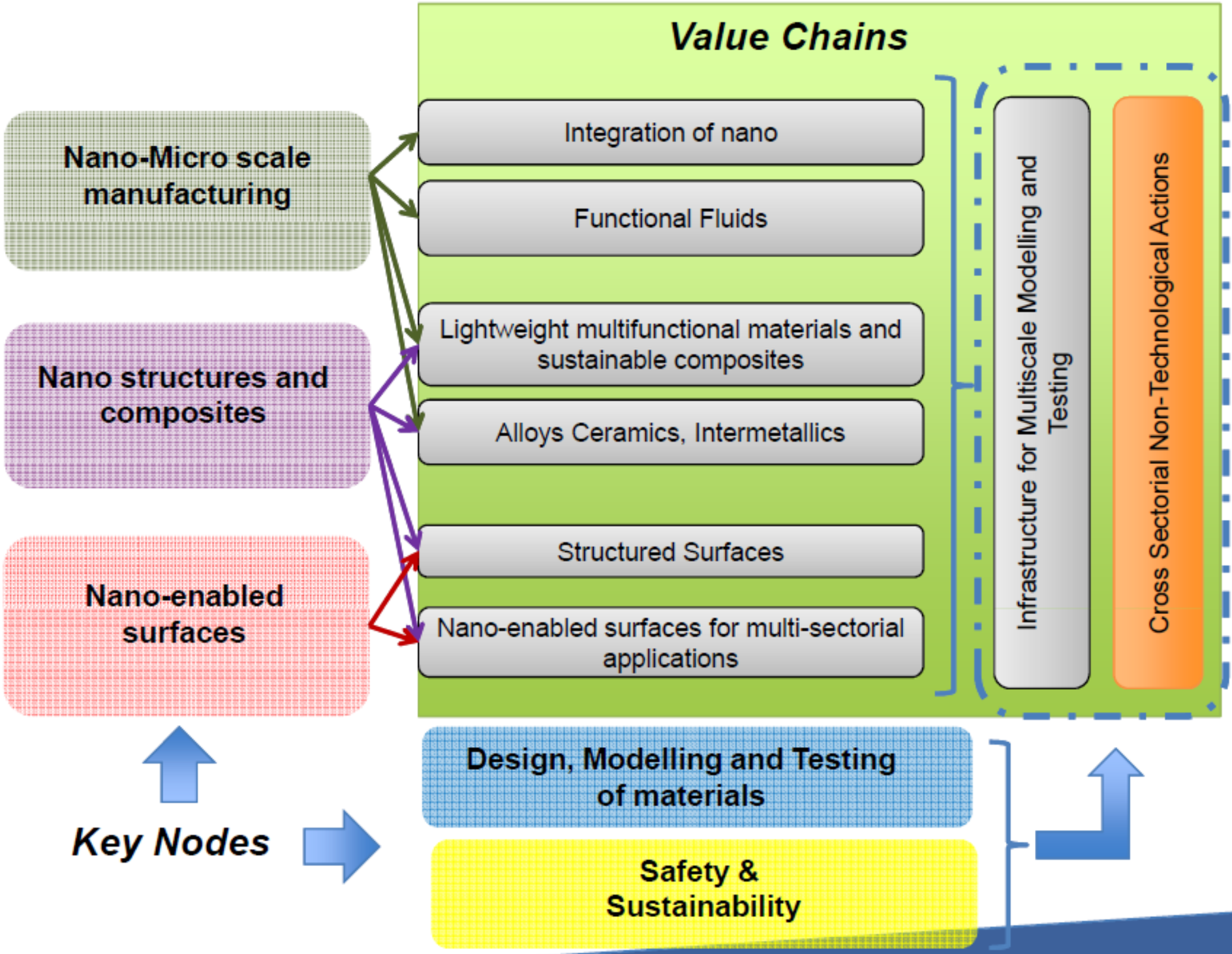
- D1.5 (→ M20): **Members Input**

  Analysis of recent and on-going EU projects, identifying on common research lines
  → classification of R&D priorities and innovation needs

- D2.3 (→ M18): **Members Input desired**

  Extended contribution to the **Integrated Industrial and Research Roadmap** and related **Implementation Plan**
  → focussed on industrial needs, through revision / development of documents, discussions, etc.

NANOfutures Draft Roadmap



NANOfutures Roadmap Consultation – Praise

-… a massive, thorough listing of markets, chains, technologies, impressive

- A very interesting effort

- Valuable work to be sure (especially the nanocoatings)

- The roadmap content tries to cover many different areas putting attention in many useful processes and approaches

- Another important content that is covered in the roadmap is standardisation

NANOfutures Roadmap Consultation – Generell Comments

Comments from Members:10

- 305 proposed actions, but many are repeated
-Will there be a table linking actions with VC (to see the cross-interests)?

=> Comment co-ordinator: action is repeated for instance in VC1a, VC1b and VC1c: this means that there is only one action (one funding effort) but will be useful for different value chains.

-A ranking in urgency (within short, medium, long term)

- Safety issues must be considered in all new developments related with nanotechnology.

NANOfutures Roadmap Consultation – Improving Comments

- though most of it is too general-it could be applied to any technology.

- Key words missing are: "atomic precision", "massively parallel", and "bootstrapping."

- Very chemically focuses, most of the focus is on thermodynamic-driven processes and their resulting products, but not really nanotechnology.

- If the process is not repeatable, atomically precise, and programmable in 3D with heterogenous patterns over a wide range of atoms, then it's not a general purpose nanotechnology.

- Safety it has to be considered in most of the applications at the beginning of the VC =>Taking into account safety issues in the whole VC

- What needs more effort is the standardization processes

- There is a real demand in nanotechnology areas, especially from the end users in the definition of a clear normative and standards. We consider that in all the VC the development of standard protocols must be developed.

NANOfutures Roadmap Consultation – VC1

VC1a - Lightweight multifunctional materials and Sustainable composite for TEXTILES and SPORT SECTORS – slide 42

“…The use of nanomaterials (higher surface area) has advantages in terms of filling the cement matrix, densifying the structure, resulting in higher strength and faster chemical reactions (e.g. hydration reactions)....”, ...” potential application of textile nanostructure in the medical sectors for the production of bio miming nanostructure to be used as scaffold in tissue engineering...”, ...” improvement of thermo-regulation and in the transpirability of the clothes. application of high porous and light material combining vapour transport and Phase change materials could be applied...”.

“... Nanoporous textiles. Composites with added functionality...”
Name of the proposed technology: Atmospheric plasma technology
Timeline: short and medium term

NANOfutures Roadmap Consultation – VC1

VC1c - Lightweight multifunctional materials and Sustainable composite for TRANSPORTATION – slide 44

"...limitations and challenges for nanocomposites production. These include:
Processing: Compatibility (only a limited number of plastic matrices are compatible with nanoclays/nanotubes/nanofibers
Cost: The production of nanocomposites on a commercial scale at viable prices,
Consistency and reliability in volume production: It is possible to get consistency and reliability in volume production materials to a great extent.
High lead time: Commercializing the end-use products would take a longer time, mainly due to stringent approval and OEMs acceptance.

VC1d - Lightweight multifunctional materials and Sustainable composite for ENERGY – slide 45

"... Collaborative research project are required since several parameters and aspects must be set up in order to optimise lightweight and high density batteries' components, inclusing conductive materials (i.e. polymers)…"

NANOfutures Roadmap Consultation – VC2

VC2b - Plasma and vacuum engineered nano enabled surfaces for multisectorial applications –slide 58

Action: plasma and vacuum based deposition of novel nano-enabled thin films on rigid and semiflexible metallic substrates
Name of the proposed technology: high intensity pulsed plasma beams (HIPPB)
Changes of steels surface morphology as a result of interaction with intense pulsed plasma beams containing ions of rare earth elements
Timeline: short term

NANOfutures Roadmap Consultation – VC3

VC3a – Structured Surfaces for TEXTILE passive functionality – slide 51

"... Since technical properties are more important then aesthetics one it is crucial to have different functionality on the surface according to the final use of the products. Plasma treatment could allow to modify the chemical composition of the surface enabling to produce multifunctional surfaces that cannot easily produce by conventional finishing methods.
The new design and optimisation of atmospheric plasma in terms of process versatility (gas to be processed, effectiveness of aerosol dispersion of the reactive compounds) must be addressed in order to allow a significant spread of the technology at industrial level.
RTD Collaborative project are required since new design is required..."

VC3c – Structured Surfaces for Textile passive functionalities - slide 53

"...2D and 3D – Plasma treatments optimization and integration on fibers and fabrics combined with deposition technologies..."
Name of the proposed technology: Atmospheric plasma technology
Timeline: short and medium term

NANOfutures Roadmap Consultation – VC6

VC6b – Integration of Nano: finished net shaped (regenerative medicine) – slide 66.
Reference Action (s): Materials – Modelling: Unified methodologies for design of nano-enabled materials and products

Name of the proposed technology:
Biomimetic and biomechanics approach for new design prostheses integrated with hybrid and nanocomposite materials
Timeline: Short (2015)

VC6c – Integration of Nano: direct manufacturing (regenerative medicine) – slide 67
Reference Action (s): Materials – Modelling: An overall materials&product design system architecture

Name of the proposed technology:
New design biomimetic-prostheses - Use of biocompatible materials for bioactive hybrid materials and nanocomposites scaffolds for early osteointegration
Timeline: Medium (2020)

NANOfutures Roadmap Consultation - Actions

VC1 - **Lightweight multifunctional materials and Sustainable composite**

Action: Analysis and process control of dispersion of nanofillers
=> The novelty of this action, with respect to the up-to-date methods, may include an in-line control that is strictly correlated with the chemical and morphological features (mainly polarity and aspect ratio) of the nanofillers with respect to the matrix.

Action: Collaborative projects should be required in order to optimise the production of this kind of materials and to realise an exploitable products.

Action: Collaborative research activities among textile producers, polymer producers and end-users are needed

Action: Composites with added functionalities, development of methods for functionalization during synthesis, multilayer materials, analysis and process control of dispersion of nanofillers into polymers,
Technology:Chemical and mechanical functionalization, Timeline: short to long term

Action: Development of cost effective industrial scale technologies for synthesis and technologies for dispersion,
Technology: Extrusion assisted by ultrasounds , Timeline: medium term

Action: Nanomaterials extrusion, rapid solidification,
Technology: Novel injection methodologies
Timeline: medium term

NANOfutures Roadmap Consultation - Actions

VC3 - **Nanostructured Surfaces**

Action: 2D & 3D – Plasma treatments optimization and integration on fibers and fabrics combined with deposition technologies
=> its major challenge concerns the optimization of the plasma treatments for achieving the best final performances of fibers and fabrics after the deposition step, using a very limited number of deposition steps and thus increasing the productivity of the process.

NANOfutures Roadmap Consultation - Actions

VC5 - **FUNCTIONAL FLUIDS**

Action: Cost effective industrial scale technologies for filler synthesis and technologies for dispersion
=> The challenge mainly refers to the scale-up of the technology and processing that have already been set at a lab scale.

NANOfutures Roadmap Consultation - Actions

VC6 - **Integration of Nano**

Action: Reactive/in situ production in process generation of nano-features
=> requires the industrialization and in-line processing of nano-features, which nowadays have been achieved only at a lab or pre-industrial scale. This challenge could be very beneficial for increasing the productivity of nano-systems, maybe exploiting the same apparatuses that are already used for “standard” industrial productions.

NANOfutures Roadmap Consultation - Missing points

1) Epitaxy seems to be missing. Specially epi on patterned substrates.
2) Nano-lego assembly is missing.

Name of the proposed technology:

Nanolegotronics- building electronics piece by piece.

Timeline: Medium term

This is a novel approach. Sometimes you have to build something piecewise, if not one could not make the complex circuits/components.

3) Techniques/methods for design, modelling and testing of materials

Action: “Multiscale and Multiphysics modelling technologies for a range of material systems and various key problems”

Timeline: short to medium term

“...Defining automatic tools for parametrization of different modeling layers (both bottom-up and top-down). The final product should be able to compensate lacks of information in developing multi-scale models by providing some reasonable estimates (together with proper uncertainties and confidence levels)...”

Thank you for your attention!

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