SINTEF REPORT

SINTEF

Address: P.O.Box 124, Blindern
0314 Oslo NORWAY
Location: Forskningsveien 1
Telephone: +47 22 06 73 00
Fax: +47 22 06 73 50

Enterprise No.: NO 948 007 029 MVA

TITLE

Nanotechnology in SINTEF: Overview, Strategy and Recommendations

AUTHOR(S)

Duncan Akporiaye, Ralph W. Bernstein, Lars Kilaas, Andreas Vogl

CLIENT(S)

SINTEF

REPORT NO.	CLASSIFICATION	CLIENTS REF.	
	Internal	Unni Steinsmo and Aage Thunem	
CLASS. THIS PAGE	**ISBN**	**PROJECT NO.**	**NO. OF PAGES/APPENDICES**
Open			41
ELECTRONIC FILE CODE		**PROJECT MANAGER (NAME, SIGN.)**	**CHECKED BY (NAME, SIGN.)**
		Ralph W. Bernstein	Torstein Haarberg
FILE CODE	**DATE**	**APPROVED BY (NAME, POSITION, SIGN.)**	
	2004-03-18	Unni Steinsmo, President	

ABSTRACT

A Strategic Working Group (SWG) was established to develop SINTEF's strategy within Nanotechnology with representatives from SINTEF ICT and Materials and Chemistry.

SINTEF looks upon nanotechnology as an important strategic area which provides unique opportunities due to the inter- and multi-disciplinary character and skills of the organization. The prioritization of strategic research within selected fields can open new markets and therefore points to an application-oriented approach which should take account of criteria; based on core expertise where SINTEF has critical mass, this being supported by basic research at a high international level and linked to activities where SINTEF or its strategic partners operate state-of-the-art infrastructure. A prerequisite to building a solid platform for success in nanotechnology are is through alliances, in particular with the universities NTNU in Trondheim (Nanolab) and UoO in Oslo (MiNaLab).

SINTEF has a considerable level of resources and activities covering all aspects of the field. Mainly centred within the two divisions (SINTEF Materials and Chemistry and SINTEF ICT). A dialogue with relevant bodies and organisations has revealed that potential customers have shown a cautious and critical interest and have limited activities in this field at the present time. Health, Environment, Safety and Ethics issues are naturally considered to be important aspects of Nanotechnologies that must be thoroughly accounted for, particularly when such technologies are being actively investigated in projects and may result in products that become widely available. The SWG has thus proposed a set of recommendations, with concrete follow-up actions that have been linked to high level goals.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Materials Technology	Materialteknologi
GROUP 2	Nanotechnology	Nanoteknologi
SELECTED BY AUTHOR		

TABLE OF CONTENTS

1 Executive Summary

A working group was established to develop SINTEF's strategy within Nanotechnology with representatives from SINTEF ICT and Materials and Chemistry, to report to SINTEF's top management with respect to SINTEF's investment in Nanotechnology over the next 5 years. This strategy has been developed through extensive dialogue, both internal, within SINTEF and outside of SINTEF.

SINTEF looks upon nanotechnology as an important strategic area which provides SINTEF with a unique opportunity due to the inter- and multi-disciplinary character and skills of the organization. Though in many aspects it is still a field in the early stage of development, it is important for SINTEF also to be involved in this first phase, including through being a partner in basic research projects.

The prioritization of strategic research within selected fields can provide the opportunity of opening new markets or be the basis of stimulating a new market base for SINTEF services, either through commercialisation via spin-off companies or technology take up by new high technology. This therefore points to an application-oriented approach to the strategy, which should take account of certain criteria; based on core expertise where SINTEF has critical mass, this being supported by basic research at a high international level and linked to activities where SINTEF or its strategic partners operates state-of-the-art infrastructure.

Much has been written about the potentially huge market opportunities in Nanotechnology, but from SINTEF's perspective this market is split into markets for a) nanotechnology-based products and b) Research and Development services. It is noted that an underlying problem of market reviews is the difficulty of determining how much the value of the final products should be ascribed to the nanotechnology component. It appears clear, however, that there are major opportunities for products and services based on new technologies related to nanoparticles and nanoelectronics

An integral part of the development of SINTEF's strategy for Nanotechnology has been a dialogue with important partners of SINTEF in addition to other relevant bodies and organisations. The overall impression given by potential customers has been that they have limited activities in this field at the present time and have thus not developed a significant strategy regarding Nanotechnology. In general most have shown a cautious and critical interest, with the view of waiting to see whether nanotechnologies become relevant for their core activities.

An absolute prerequisite to building a solid platform for success in Nanotechnology is to establish alliances with regard to infrastructure, especially for a small country like Norway. A natural focus is the established alliances with the universities NTNU in Trondheim (Nanolab) and UoO in Oslo (MiNaLab).

SINTEF's previous review of its activities defined under the umbrella of Nanotechnology reveals a considerable level of resources and activities covering all aspects of the field. These activities have been differentiated into the 3 main divisions of "Particle Systems", "Bulk Systems" and "Interface Systems". Solicitation of additional input resulted in feedback from only two divisions (SINTEF Materials and Chemistry and SINTEF ICT) out of six divisions within the SINTEF Group and it is clear that Particle Systems are very central in many of the applications described. Surprisingly, very little feedback has been obtained on bio-related nanotechnology without involving nanoparticles.

Health, Environment, Safety and Ethics issues are naturally considered to be important aspects of Nanotechnologies that must be thoroughly accounted for, particularly when such technologies are being actively investigated in projects and may result in products that become widely available.

The SWG has thus proposed a set of recommendations, with concrete follow-up actions. These recommendations have been linked to following high levels goals:

- Taking advantage of the inter-disciplinary nature of Nanotechnologies through synergy between the different divisions in SINTEF, particularly in the interface of Materials and Chemistry / ICT and promoting this synergy through concrete actions.

- A proactive mechanism should be established to increase the awareness and knowledge of the industry within in the field of Nanotechnology. SINTEF could have an important role in identifying Nanotechnology developments that are relevant for industry, and to facilitate adoption of Nanotechnology in future industrial products.

- SINTEF ICT and SINTEF Materials and Chemistry represent core disciplines for innovation with Nanotechnology and this is already represented in a number of projects, programs and developments in a variety of key Nanotechnologies. Though the opportunities of synergy between the two units are already being implemented in a number of projects, the critical role of these two units should be given a clear focus.

- As a means for establishing a closer relationship and interaction between groups working in fields with potential relevance for Nanotechnology, a mechanism for co-locating and/or co-hosting of relevant groups in each others laboratories should be established.

- SINTEF should become involved in the relevant programs, both National and International, within which standards, work practices and guidelines relating to HES and Ethics are to be developed. SINTEF should also establish a mechanism for reviewing of current and planned activities and establish guidelines where relevant.

- As a basis for sharing Nanolab laboratories, SINTEF should follow up the invitation from NTNU relating to showing financial commitment. To be followed up after the Nanolab business plan has been communicated to SINTEF via the Ad Hoc Committee (SINTEF, Ralph W. Bernstein, Torstein Haarberg)(NTNU, Thomas Tybell, Bjørn T. Stokke).

- SINTEF shall be proactive in developing the newly established Gemini centres CATMAT, MiNaLab and “Materials & Energy” as platforms for the collaboration with UoO SMN and NTNU Nanlob within the field of nanotechnology and recognize MiNaLab as an important infrastructure for nanotechnology in SINTEF Oslo..

- Since FUNMAT has achieved national recognition, SINTEF should use FUNMAT actively, both to strengthen relations between the four FUNMAT institutions within functional materials and Nanotechnology, and as a lobby instrument.

- There are several EU level Technology Platforms (TPs) that are relevant for nanotechnology. Examples are Nanoelectronics, Nanomedicine, MANUFUTURE, Textiles and Clothing (ETP-FTC), The European Hydrogen and Fuel Cell Technology Platform - HFP and EuMat. Because of the large involvement of industry in these TPs, SINTEF should participate in such TPs, also without funding.

2 Background

2.1 Mandate

Mandate to the Strategic Working group (SWG), 2004-06-01 (translated from Norwegian):

"A working group has been established to develop SINTEF's strategy within Nanotechnology. The group is composed of representatives from ICT: Ralph W. Bernstein and Andreas Vogl. And representatives from Materials and Chemistry: Duncan Akporiaye and Lars Kilaas. Torstein Haarberg is appointed as leader of the working group.

The working group will report to SINTEF's top management through Unni Steinsmo and Aage Thunem. The work will conclude in a strategy document which will provide guidance with respect to SINTEF's investment in Nanotechnology over the next 5 years, with a statement of required budgeting and financing. A concrete budget should be developed for 2005 with a financing proposal of SINTEF's nanotechnology investment.

Work description and guidelines:

- *Proposed strategy to be anchored in SINTEF's business strategy*
- *Proposed strategy to identify within which areas SINTEF should best focus strategically*
- *Opportunities both further development of established industry as well as commercialisation of new operations should be taken account of.*
- *Current relationships with our main partners NTNU and UoO should be preserved.*
- *SINTEF aims to have common lines of development with our main partners with respect to its strategy within nanotechnology. The Gemini concept should be considered as a goal for this cooperation.*
- *Dependent on needs, the importance of national coordination and cooperation should be addressed. The FUNMAT agreement is to be a precondition for this work.*
- *The resulting proposal should be realistic, visionary and operational*
- *The working group should have as its starting point existing internal background material (SINTEF's status report "Nanotechnology in SINTEF – Status Report", March 2004). In addition, the group should also actively take account of equivalent background documentation from NTNU and UoO, departments/research council and strategic industry partners wherever available.*
- *The resulting proposal should take account of strategies of central laboratories and programs (Aforementioned FUNMAT) such as the NFR Foresight 2020, NTNU Nanolab, MiNaLab, Ugelstadlaboratory and the Centre for Material Science and Nanotechnolgy at the UoO."*

2.2 Overview

The SWG has developed its strategy based on the following process:

1. Internal dialogue within the group and review of the field of Nanotechnology.
    - At least 24 face-to-face meetings and telephone conferences were organised in the period June 2004 – February 2005, including review of published literature, attendance of conferences.

2. Internal dialogue within SINTEF and review of the nanotechnology activities at SINTEF
   - Evaluation of the SINTEF situation report (SINTEF Report STF24 A04003) and meetings with key members involved in drafting the report.
   - Request for input from scientist active or engaged in the area of Nanotechnology
   - More detailed request for proposal of research activities across the SINTEF organisation
3. External dialogue outside of SINTEF and information gathering.
   - Site visits, meetings and telephone interviews with a selected range of representative individuals, institutions, organisations and companies

The SWG had one midterm status meeting on the 5th October 2004 with its customer group, Unni Steinsmo and Aage Thunem, to present the status and on-going approach of the SWG. During this meeting the SWG received important feedback.

The SWG sent an email update of its status in December 2004 to its customer group, Unni Steinsmo and Aage Thunem, to present the status and on-going approach of the SWG. During this meeting the SWG received important feedback.

3 General Guidelines

3.1 Guidelines

In the mandate description it is already stated that SINTEF looks upon nanotechnology as a strategic area. It is thus key for SINTEF to establish the required expertise, infrastructure as well as national and international collaborations with a focus on a future contract research market. This means that SINTEF's role mainly will be to transfer results from basic research into strategic technology projects, development of industrial applications and business development. SINTEF should thus aim for an overlapping function between academia and industry. Nanotechnology is still a field in its early stage of development, it is, however, important for SINTEF also to be a partner in basic research projects conducted at the universities. The Strategic Working group (SWG) also believes that the inter- and multi-disciplinary character and skills of the SINTEF organization may give us a unique opportunity and enable us to take on a special role as an integrator in the development of applications based on nanotechnology.

The strategy group has based its work on the following additional general guidelines:

- Nanotechnology is a focused area in SINTEF both in Trondheim and Oslo

- SINTEF will develop the field of nanotechnology in partnership with The Norwegian University of Science and Technology (NTNU) and The University of Oslo.

- The strategy should be open to all our partners.

- It is crucial for SINTEF to establish strategic alliances with organizations abroad. This is especially important in order to be a preferred partner in EU projects.

3.2 Definition

Many definitions of the term nanotechnology are available in the literature and the public domain. Many of these definitions are general in character, and to a large extent cover conventional technologies such as chemical synthesis and biotechnology and hence, the potential novelty of nanotechnology as a field tends to disappear. It is also clear that the term "nanotechnology" covers vast numbers of technologies, a fact that complicates establishment of a precise definition. The National Nanotechnology Initiative (NNI) in USA (http://www.nano.gov/html/facts/whatIsNano.html), use the term "nanotechnology" only if it involves **all** of the following:

1. Research and technology development at the atomic, molecular or macromolecular levels, in the length scale of approximately 1 - 100 nanometer.

2. **Creating and using structures, devices and systems that have novel properties and functions because of their small and/or intermediate size.**

3. (Ability to control or manipulate on the atomic scale.)

The SWG finds this definition relevant as a platform for the strategy process because of its strong applications focus with devices, structures and systems as central elements. The group will, however, put most weight on criteria 1 and 2, and less focus on paragraph 3 of NNIs definition.

3.3 Criteria for prioritization

As mentioned above a central part of a strategy for nanotechnology will be to prioritize strategic research within fields that may open new markets for SINTEF. The Strategic Working group suggests that selection of potential strategic areas should be based on the following main criteria:

A prioritized area within in the field of nanotechnology should be:

- Based on core expertise and technology platforms where SINTEF already has a critical mass of resources and project portfolio.

- Supported by basic research at a high international level carried out by SINTEF's strategic partners or by SINTEF it self.

- Based on activities where SINTEF or its strategic partners operates state-of-the-art laboratories or other infrastructure

- Application-oriented and have an industrial potential within a time frame of 5-10 years, and where national advantages and priorities are taken into account.

3.4 Key issues in the strategy process

The strategy will deal with the four main dimensions: infrastructure, human resources, strategic projects and alliances.

Critical issues with in these fields could be:

- Available laboratory facilities
- Expertise development / competence strategy / recruitment
- Selection and financing strategic projects
- Establishment of technology platforms
- Relevant industrial partners
- Coordination and co-location

4 Market Analysis

4.1 General Perspective

The area of Nanotechnology has been characterised by an explosive growth in interest which has been reflected by channelling of major financial resources, particularly through national research councils and research programs to support research, development and commercialisation.

Due to the highly interdisciplinary nature of many of the nanotechnology developments, there has been a particular interest in obtaining innovative synergy effects through the integration of previously separate or poorly linked disciplines and technology. This additional potential of developing truly novel technology with the opportunity of establishing completely new markets is one of several reasons for the extremely high interest, leading to some critics characterising this focus on Nanotechnologies as bordering on “hype”.

From SINTEF’s perspective, the allocation of R&D funding to nanotechnologies might be expected to follow the classic profile for new “hot” areas, though in this particular case the engagement and size of such funding has been very sizeable. As shown in Figure 4.1, the development of the funding level to these types of “hot” areas may be predicted to follow two major phases or waves.

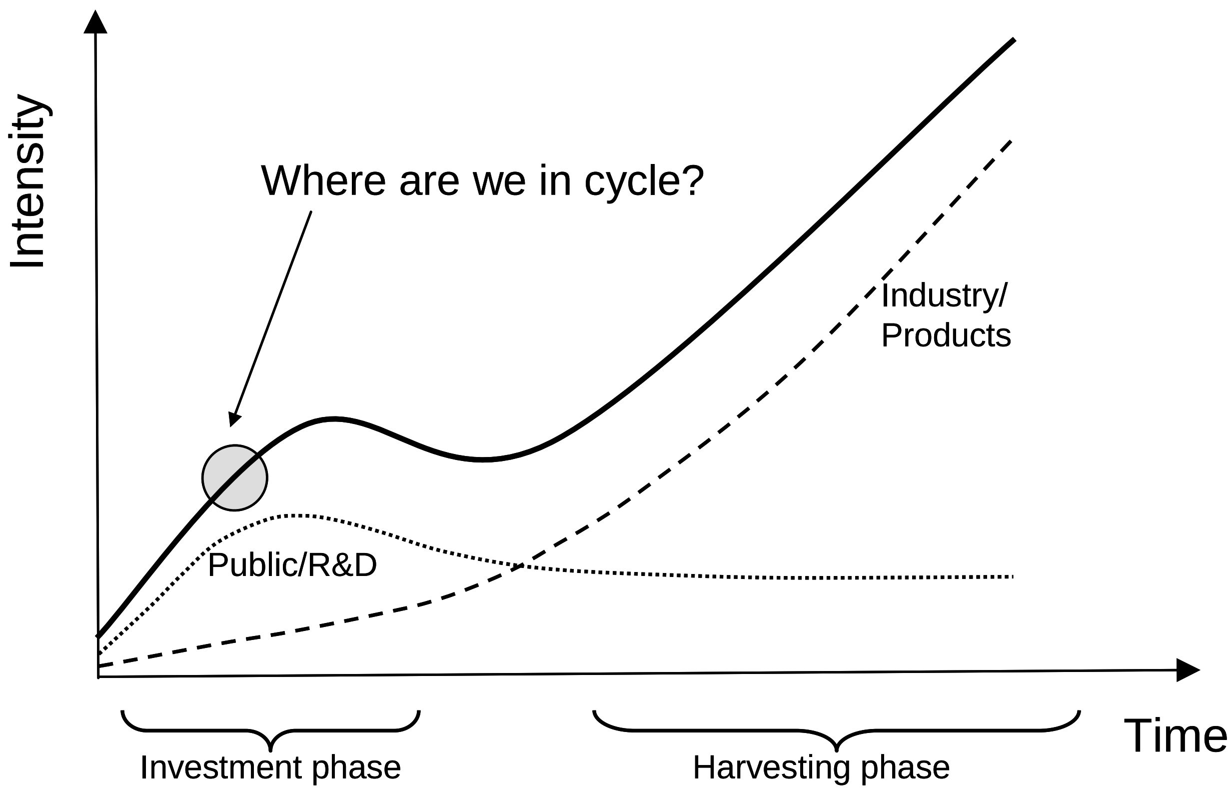


Figure 4.1 Classic cycle in the intensity of activities within new “hot” technology areas

- *The” academic” wave:* An initial phase of rapid growth during which major funding on research is primarily through public/national programs which aim to establish fundamental knowledge in order to establish national / regional expertise and competitiveness. This phase is predicted to reach a peak, after which public funding tails off, through expectations for the commercial benefits to begin to provide a sustainable basis for further innovation.

- *The" industrial" wave:* The second phase of slower growth in research funding would be catalysed by a more commercial focus led by the successes in the development of commercial technology.

It should be noted that Figure 4.1 represents a grossly simplified picture, trying to emphasize some possible major trends. An important question is how far along the development curve we currently are, since it can be an important factor for SINTEF's strategy? Since SINTEF's expectations are to play a key role as a partner with industry in the innovation and pre-commercialisation phases of nanotechnology (second phase), it is important that SINTEF is also engaged in the first phase in order to establish the expertise to position itself as a worthy partner. This entails a strategy of actively participating in the public funded programs, either through the use of current expertise which allows SINTEF to provide a leading role in specific nanotechnologies, or through partnerships to enter selected strategic areas that compliment current expertise.

Together with our industrial and academic partners, SINTEF should play a role in bridging the gap between the first and the second phase (i.e. minimizing or eliminating the "valley" in Figure 4.1).

From SINTEF's perspective, this market is of two types: a) Market for products and b) Market for Research and Development services.

4.2 Market Overview: Products

At the current (early) point in the development cycle for nanotechnologies, it is difficult to have a complete overview of the market for nanotechnology. This is the reason that total market potential presented by a number of sources vary widely from highly optimistic predictions, to more conservative levels. One key complication in quantifying the market, particularly for nanotechnology products, is the difficulty of deciding whether only the market value of the nanotechnology component should be included, or whether the total value of the finished product should be assessed. In the former case, the actual market value could be a fraction of a percent of the total product value (e.g. coating), however in the latter case, the market for the product may not exist without the specialised function of the nanotechnological component (e.g. sensor).

As shown in Table 4.1, the National Science Foundation in USA predicts a world market for nanotechnology products as of the order of 1 000 000 million USD by 2015. This market value can be differentiated according to products or applications. In terms of products, it is clear that the major opportunities are within particles and electronics. This may not be too much of a surprise since these technology areas have already had a strong link of function to size, thus the innovations in nanotechnologies which lead to improved understanding and expertise in the structuring of materials on a nanoscale have the opportunity of providing the most rapidly identifiable benefits.

Table 4.1, Overview of world market for products from Nanotechnologies (REF).

Market for products (2009[2] / 2015[1])	Million USD
Total world market for products[1]	1 000 000
Nanoparticles[2]	11 000
Nanocatalysts[2]	5 000
Nanoporous / Microporous materials[2]	2 120
Nanofilms[2]	2 000
Nanoelectronics[2]	20 000

National Science Foundation[1]
Business Communications Company, Inc[2]

How much the optimism with respect to the commercialisation of nanotechnology developments will be realised in practice remains to be seen, however, the cycle to “nanotechnology” components being included in everyday products being available to the general public is already complete. Products based on nanotechnology are already available on the market. In addition to electronics, highly profiled products are found within in the cosmetics and sports equipment marked. Commercialised nanotechnology is, however, found in applications within the medical, environmental, automotive and the energy areas.

4.3 Market Overview : Survey of Institutions / organisation

An integral part of the development of SINTEF’s strategy for Nanotechnology has been a dialogue with important partners of SINTEF in addition to other relevant bodies and organisations. This process was carried out as a series of interviews and meetings, with the view of getting input / feedback regarding the organisations’ own strategy / activities within Nanotechnology and the potential role that SINTEF could have in general and specific terms. An overview of the organisations contacted is given in Table 4.2 and has included major academic institutions, representatives of major funding programs as well as industry. This overview has not been planned as an exhaustive overview of all relevant organisations, but has functioned as a mechanism for identifying a variety of critical issues relevant for SINTEF’s partners and customers. Summaries of the interviews with the various organisation are given in Appendix 9.1.

Table 4.2, List of bodies / organisations contacted with respect to SINTEF's Nanotechnology strategy development.

Type / organisation	**Organisation/ Unit/Division**	**Representatives interviewed**
Research Insitutes		
SINTEF	Marine	Vegar Johannssen, Pål Lader
	ICT	
	M&C	Ragnar Fagerberg, Trond Ellingsen, Ruth Schmid
IFE		Arne Skjeltorp
PFI		Per Nygård
FFI		Randi Haakenaasen
Universities		
NTNU	Nanolab	Tor Grande, Mariann Einarsrud, Thomas Tybell
	Ugelstadlab	Johan Sjøblom
UoO	SMN	Helmer Fjellvåg
	MiNaLab	Terje Finstad
UiB		Jan P. Hansen
State Funding Bodies		
Dep.	NHD+UFD	Kristin Vinje
NFR		Dag Høvik, Astrid Brenna
Industry	UOP	Jennifer Holmgren
	Hydro Porsgr.	Ole J. Siljan
	Statoil	Erling Rytter, Kjell Moljord, Ola Olsvik, Svein Omdal, Arnt Olufsen
	Borealis	Klaus Jens
	Amersham	Lorenzo Williams
	SensoNor	Terje Kvisterøy, Per G. Gløersen
	O-Mass	Jørn Raastad
	Dynal	Lars Korsnes, Geir Fonnum
	DNV	Fabrice Lapique, Stefan Marion, Jan Weitzenböck
Investor		
	Venturos	Web site: http://www.venturos.com

The overall impression given by the SINTEF customers that were contacted has been that they have minimal activities or interest in this field at this time and have thus not developed a significant strategy regarding Nanotechnology. In general most have shown a cautious and critical interest, with the view of waiting to see whether nanotechnologies become relevant for their core activities. In certain cases, an understanding of the theoretical potential of developments in this area were acknowledged, but with strong scepticism regarding “what is new” with these approaches and the technical hurdles of making these developments work under industrial scale.

In certain specific cases, industry was open to receiving input regarding technology that was relevant for their activities and were willing to even partially fund a “Technology Scouting” activity related to Nanotechnologies.

Dialogue with two major academic institutions UoO and NTNU has been ongoing before meetings with selected representatives were held and both of these institutions have developed strategies within Nanotechnology and have to some degree established (UoO) or establishing (NTNU) dedicated laboratories and groups to work within selected nanotechnologies. Through its strategic relationship with UoO and NTNU, SINTEF will be engaged and have strategic collaborations within a range of applications within nanotechnology. The SWG has also reviewed the report “Towards Nanotechnology” a strategy for nanoscience at the University of Bergen.

Meetings with state funding bodies have reinforced the importance of SINTEF having a strategy for nanotechnology with the strong signal of complementing the available Nowegian funding levels with a proactive engagement in the new EU programs, maximising success by partnering with international groups of high standard.

4.4 Market Overview: Research and Development

Since organisations such as SINTEF’s target market segment is research and development services; on the world scale, the largest accessible market is currently the funding being applied through a range of research programs, with a significant amount of R&D also considered to be going on in the private sector. There will be additional opportunities in the latter as activities in nanotechnologies mature and industry becomes more actively involved (and comfortable?) in supporting developments in nanotechnology.

Table 4.3, Overview of world market for R&D services within Nanotechnologies (EU).

Market for R&D - 2004	Million USD
Public sector	3 000
EU	1 000
USA	1 000
Private sector	2 000

As shown in Table 4.3, in 2004 the amount of funds being channelled into nanotechnologies R&D on a world scale was predicted to be of the order of 7 000 million USD, with the EU accounting for approximately 33% of the funding from the public sector. This impressive level of funding is the result of the desire to ensure a competitive position within this new field and has been achieved by the establishment of major funding initiatives.

4.4.1 Norwegian R&D Program

A pragmatic view of SINTEF's opportunities of taking advantage of this major R&D programs would be to focus on the key programs on-going / to be established within Norway and EU. Within Norway, the major public funding of Nanotechnology has been through the NANOMAT program organised by the Norwegian Research Council. As shown in Table 4.4, the Norwegian Research Council has funded the NANOMAT program since 2002, which has provided support for a number of projects at SINTEF, though the opportunities for major research activities may be limited in the future. For 2005 funding for new projects is given at an amount of 13 MNOK. 10 MNOK of this amount are designated for BIP- and KMB projects.

Table 4.4, Overview of R&D funding to Nanotechnologies within the NANOMAT program (Norwegian Research Council).

NANOMAT funding overview	MNOK[1]
2002	8,5
2003	56,9
2004	74,5
2005	62,3
2006 (estimate)	78,3
Total (estimate)	280,5

[1]It should be noted that these figures are normally a combination of funding directed to both nanotechnology and new materials which are often not separated in the relevant research programmes.

To set the Norwegian funding levels within context, Norway's per-capita level of public funding for nanotechnology in 2003 was 1.6 EUR/capita which can be compared to the average of the EU-25 nations of 2.4 EUR/ capita. Other bigger major industrialised nations had even more significant funding, such as Japan (6.4 EUR/capita) and the USA (3.6 EUR/capita). However, it should also be noted that even minor countries also had more significant R&D funding, for example Ireland (5.6 EUR/capita) and Switzerland (3.4 EUR/capita). (REF: Communication from the commission: "Towards a European strategy for nanotechnology", COM (2004) 338)

4.4.2 EU R&D Programs

EU funding for nanotechnology has been significant during the 6th Framework Program and is expected to be even greater within the greatly expanded 7th Framework Program.
EU funding for Nanotechnology during 2003 was 350 MEUR. Thus, compared to 800 MEUR of national level funding of the member states, the EU represents almost one third of the public funding in Europe direct at nanotechnology.

The research programmes within NMP (Nanotechnology and nanosciences, knowledge-based multifunctional materials, new production processes and devices) and for IST (Information society technologies) are the main funding sources for nanotechnology, but also other research programmes might offer funding for nanotechnology projects in minor amounts (dependent on the application).

In the thematic area 1 "Life sciences, Genomics and Biotechnology for Health" work programme in the 6th framework for 2005 the term "nanotechnology" is not directly mentioned. Nevertheless,

the topics in this programme, which contain research about genomics and proteomics could be called nanotechnological topics. Biologists often do not define their research topics as nanotechnology, even if it might be nanotechnology by definition. These research areas have an indicative budget of about 392 M€. The amount of "real" nanotechnology in this sum is difficult to estimate from the descriptions.
The work programme for the IST thematic area in the 6th framework for 2005-2006 (Call 4 and Call 5) includes 254 MEUR for nanotechnology related projects such as nanoelectronics, technologies for micro/nanoscale integration, photonic components, micro/nano based sub-systems.

The third call for the NMP programme in 6th framework for 2005 includes 120 MEUR for traditional funding instruments (STREP, CA and SSA), 150 MEUR for new instruments (IPs, NoEs) [1] and 100 MEUR for IPs for SMEs, resulting in 370 MEUR in total. How much of this total will be directed at nanotechnology and relevant projects is not evident.

With respect to the 7th framework, more detailed information are recently published. (http://www.earto.org/Newsletter/Text%20bin/FP7draft.doc).

However, this program spans the period 2007-2013 with a planned budget of 10 GEUR per year, more than double the about 4 GEUR per year of FP6. For the different research areas a preliminary breakdown is published on the web (http://www.cordis.lu/fp7/breakdown.htm).
The biggest areas, which include nanotechnology, are for the cooperative projects "Information and Communications technologies" with 12.67 GEUR and "Nanosciences, Nanotechnologies,Materials and new Production Technologies" with 4.83 GEUR.

The funding instruments should be mainly maintained in FP7, but there won't be a difference between STREP and IP only a instrument called "Collaborative projects", which should be quite flexible. The existing research areas will be maintained and some new included. The focus of the existing areas is supposed to be the same as in FP6.

Since SINTEF has so far shown a good level of success in soliciting funding from the EU programs, this new call and future 7th FP provide an opportunity and mechanism for building up expertise and networks to support SINTEF's long term strategy within nanotechnology. The European Technology Platforms, Nanoelectronics, Nanomedicine, EuMat and MANUFUTURE are considered to be of special interest for SINTEF, in addition the following Technology Platforms will most likely be relevant for the areas of Nanomaterials and Nanocatalysis:

- Nanoelectronics
- Nanomedicine
- The European Hydrogen and Fuel Cell Technology Platform - HFP
- Technology Platform on Sustainable Chemistry
- Technology platform on clean and sustainable carbon based energies for Europe
- Technology Platform for Zero Emission Fossil Fuel Power Plants
- The European Technology Platform for the Future of: Textiles and Clothing (ETP-FTC)

[1] IPs (Integrated Projects) assemble a critical mass of stakeholders and financing to pursue a specific objective. They integrate all aspects of the R&D process, both technical and non-technical and can ensure the transition from nanosciences to nanotechnologies by bringing together the research and industrial communities.
NoEs (Networks of excellence) are a newly introduced concept that aims to bring together all interested stakeholders to develop a long-term shared vision, create roadmaps, secure long-term financing and realise a coherent approach to governance. This concept might be appropriate in response to the need for more synergy and coordination between various stakeholders in a specific technological area.

Table 4.5 Budget breakdown of the Seventh Framework Programme of the European Community (EC) (2007-2013) and Euratom (2007-2011) (in EUR million)

COOPERATION	Themes (Using all funding schemes. Including international cooperation.)	
	Health	**8317**
	Food, Agriculture and Biotechnology	**2455**
	Information and Communication Technologies	**12670**
	Nanosciences, Nanotechnologies, Materials and new Production Technologies	**4832**
	Energy	**2931**
	Environment (including Climate Change)	**2535**
	Transport (including Aeronautics)	**5940**
	Socio-economic Sciences and the Humanities	**792**
	Security and Space	**3960**
Total COOPERATION		**44432**
IDEAS	European Research Council	**11862**
PEOPLE	Marie Curie Actions	**7129**
CAPACITIES	Research Infrastructures	**3961**
	Research for the benefit of SMEs	**1901**
	Regions of Knowledge	**158**
	Research Potential	**554**
	Science in Society	**554**
	Activities of International Co-operation	**358**
TOTAL CAPACITIES		**7486**
Non-nuclear actions of the Joint Research Centre		**1817**
TOTAL EC		**72726**

4.5 Future market for SINTEF in Norway?

For some, nanotechnologies provide the basis of fascinating visionary future applications that are predicted to result in step changes in certain sectors of society. However, contrasting perspectives characterise the situation as “hype” and classic “technology bubble”. Within Norway, the current perception of industries' engagement in nanotechnology is of "cautious scepticism". This viewpoint is based on a variety of factors including:

- Natural hesitancy to see how things develop in a rapidly evolving field
- Considered lack of relevancy of nanotechnologies to their areas of application
- Negative views to the viability of commercialisation of products (scale-up, stability, etc)

With respect to engaging industry to support an R&D focus on nanotechnologies, SINTEF can play a major role in the relevance of nanotechnology to applications areas of importance to industry. As shown in Figure 4.2, SINTEF's strategy can involve partnerships that enable Norwegian industry to realise commercialisable nanotechnology.

A concrete role in this strategy could be of "applications scouting" in which active dialogue with industry through visits, fora, seminars, etc can be used as mechanisms for engaging them to develop a strategy that evaluates the potential of developments in nanotechnologies with respect to their own activities.

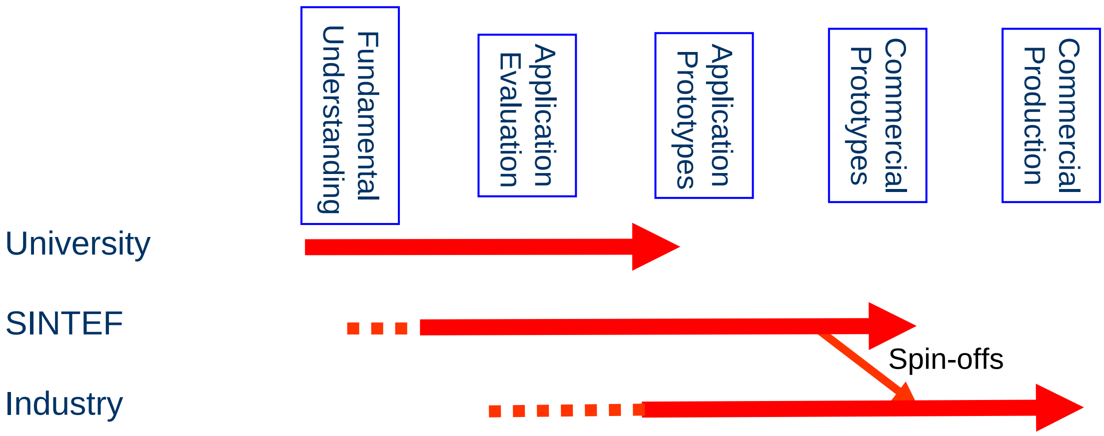


Figure 4.2 SINTEF's potential role in knowledge chain

In terms of publicly funded R&D, SINTEF already actively participates in the NFR funded program NANOMAT, which is currently the most important national source of funding of Nanotechnology research. With a tentative planned doubling in annual budget from the proposed 78.3 MNOK of 2006 (Table 4.4) to ca 165 MNOK in 2010, the NANOMAT program will continue to be key funding source for SINTEF. SINTEF should therefore have the strategy of developing high quality proposals that position developments in technology and expertise for accessing the Norwegian market as well as competing for the growing EU R&D funds.

The development of new Nanotechnologies, either by SINTEF or its partners, if successful can also be the basis of stimulating a new market base for SINTEF services, either through commercialisation via spin-off companies or technology take up by new high technology companies. In terms of commercialisation of SINTEF generated IP, SINVENT will have the same role regarding Nanotechnology as for other areas in SINTEF. SINVENT has no special focus on Nanotechnology-based IP, neither does SINVENT see that all such new technology really can be justfied as being "Nanotechnology". SINVENT is currently only involved in one nanotechnology platform based on nanoparticles (JPT). The need for a special strategy for commercialisation from Nanotechnology activities should however be reviewed at a later stage. This should be done in cooperation between SINVENT and SINTEF Core.

The experience from establishing the ongoing national effort on microtechnology shows that industrial users should be involved already in the planning phase of strategic initiatives and programme proposals. Another key point for possible commercialisation is the availability of infrastructure for prototyping and small scale production for SMEs and start-ups. This has to be promoted by SINTEF in e.g. possible involvement in NTNU Nanolab.

As shown in Table 4.6, there is a promising track record from national effort on micro technology and the investment in the MiNaLab for industrialisation of microsystems.

Table 4.6, Examples of SINTEF former and present Norwegian customers within Microsystems Technology

Norchip	LifeCare
Alertis Medical	ame
SensoNor	Simrad Optronics
VivId	Idex
ABB	Aker Maritime (MWS)
Ignis Photonyx	Tomra
Presens	IDEAS
MemsCap	Nera
BioMolex	Nammo
Q-free	

Recent start up companies and other initiatives exploiting nanotechnology is also already evident, e.g.:

- ReVolt: (Battery technology)
- JPT: (Yellowing and scratch resistance transparent polymers)
- Keranor (e.g. “NanoCaps”, EU project)
- Diamond Nanomachines (Sensors and actuators based on carbon nano composites)
- n-tech (Production of carbon nanotubes)

4.6 Recommendations

An overview of the market for nanotechnologies has shown that within the short term, major R&D funding, particular from the public sector, will be channelled to establish regional competitive positions. Funding from the EU research programs (see chapter 5) appear to provide one opportunity for SINTEF to build up and strengthen strategic areas within Nanotechnology, together with its Norwegian partners and a network of high calibre international partnerships. With respect to the market analysis, the following recommendations are given:

- EU funded research activities should be used as instruments to position SINTEF’s expertise with respect to the long term goal engaging industry into performing research activities within nanotechnology.

- SINTEF should get involved in European Technology Platforms that are relevant for nanotechnology, such as Nanoelectronics, Nanomedicine, EuMat and MANUFUTURE which are considered to be of special interest for SINTEF.

- Due to the very cautious view of Norwegian industry to nanotechnologies, SINTEF should establish a proactive strategy of “Technology Scouting” giving SINTEF a role of active dialogue with industry to help identify nanotechnology developments that are relevant for their applications.

- SINTEF should develop the industrial potential based on in-house technology platforms and carry out internally funded interdisciplinary strategic projects in order to generate IPR and put SINTEF in the position as a attractive collaboration and development partner.

- SINTEF should promote establishment of “independent” infrastructure for prototyping and/or small scale production of components or materials based on nanotechnology.

5 Alliances and infrastructure

5.1 Infrastructure at a national level

An absolute prerequisite to building a solid platform for success in Nanotechnology is to establish alliances with regard to infrastructure, especially for a small country like Norway.

SINTEF's location in both Oslo and Trondheim makes it natural to focus primarily on alliances with the universities NTNU in Trondheim and UoO in Oslo. The structure of such a collaboration is already in place in Oslo through the establishment of the MiNa laboratory and the corresponding "Gemini Center MiNaLab" (Microsystems and Nanotechnology laboratory) for strategic co-operation between SINTEF and UoO. Concerning NTNU's plans for a Nanolab at Gløshaugen (tentatively budgeted as 220 MNOK), an Ad Hoc Committee was formed during spring 2004 with two members from each organisation, Professor Thomas Tybell and Professor Bjørn Torger Stokke from NTNU, and Dr Ralph Bernstein and Dr Torstein Haarberg from SINTEF. In order to share these laboratories with SINTEF, there is an expectation from NTNU that SINTEF will show financial commitment. A business plan for the Nanolab is currently under development, and this will be communicated to SINTEF via the Ad Hoc Committee.

It should be noted that the FUNMAT consortium (NTNU, IFE, SINTEF, UoO) has played an important role in co-ordinating investments in the area of functional materials and nanotechnology, amounting to 137.6 MNOK, through funding channelled through the NANOMAT program.

5.2 FUNMAT - Functional Materials

5.2.1 Background for the FUNMAT initiative

In the late 1990's Prof. Helmer Fjellvåg at UoO took the original initiative laying the basis for FUNMAT. In 2001 the four major organisations working with materials science in Norway, NTNU, UoO, IFE, and SINTEF, jointly proposed a strategic plan concerning functional materials. While the researchers recognised that developments in functional materials were imperative to obtain a continued sustainable growth in the society, there was little funding available for R&D. By developing a coordinated strategy, the FUNMAT initiative promotes

- optimum use of resources (man-power and laboratory facilities)
- synergies between complementary research groups
- international collaboration
- integration of activities from basic research to innovation

Building on internationally recognised research groups, the FUNMAT plan argued for a significant increase in the funding of such research, to a level of 150 million NOK per year. It should be acknowledged that such a substantial effort is required in order to provide substantial academic and industrial results.

It is generally recognised that the FUNMAT initiative was an essential contribution to the establishment of the NANOMAT programme currently run by the Research Council of Norway.

5.2.2 Organisation of FUNMAT

FUNMAT is organized as a consortium. The consortium agreement was signed during spring 2004 by the top management of the four member organizations. Two groups have been organised to run FUNMAT:

- *The Leader Group* consisting of one representative from each member organization is the decision making body on strategic issues. This group, which currently is headed by Prof. Knut Fægri, UoO, actively communicates the FUNMAT strategy with political and bureaucratic entities. The other members are Terje Østvold, NTNU, Eva Dugstad, IFE and Torstein Haarberg, SINTEF.
- *The Working Group*, consisting of two representatives from each member organization, provides background information to the leader group. The working group, currently headed by Prof. Tor Grande, NTNU, also ensures that relevant information is shared between the member organizations on a day-to-day basis.

In addition, FUNMAT has established a secretary function, currently filled by Senior Scientist Ragnar Fagerberg, SINTEF.

As of 2005, three large and a few smaller research projects have been initiated through coordinated FUNMAT actions. The three larger projects concern Materials for Hydrogen Technology (42 MNOK), Functional Oxides for Energy Technology (36 MNOK), and Functional Oxides for Information and Communication Technology (52 MNOK). These projects started in 2003, and will be completed in 2006-07. Projects to build or purchase scientific equipment have been awarded an additional 24 MNOK. The Research Council of Norway has awarded FUNMAT with a total funding of approximately 160 MNOK for the period 2003-2006. The leader group acts as a steering committee for the above mentioned projects.

5.2.3 FUNMAT Strategy in a SINTEF perspective

SINTEF's strategy with respect to FUNMAT should be based on the following guidelines:

- FUNMAT has achieved national recognition, and FUNMAT should be used actively from a SINTEF perspective, both to strengthen relations between the four FUNMAT institutions within functional materials and nanotechnology, and as a lobby instrument.
- FUNMAT has played an important role in the co-ordination of resources (man-power and laboratory facilities), and this should be supported also in the future whenever appropriate.
- Within FUNMAT's field of co-operation between NTNU, UoO, SINTEF and IFE, the consortium should be used actively to promote the best projects and ideas to come forward in the future. However, with respect to prioritization, there is a delicate balance between complete openness and focus. There is a rationale behind the selection of what became the present FUNMAT projects, where selections were made on the basis of documented scientific excellence and critical mass, combined with future needs at a national level. Naturally, those who pioneered this co-operation format also obtained a head start. All this being said, the selection of future priorities within the FUNMAT consortium should be based on open processes, anchored both in the FUNMAT organisations' relevant research groups and at management level (i.e. FUNMAT's leader group). A more detailed operational plan for this revitalisation of FUNMAT is not worked out yet, but it is on top of the agenda for FUNMAT's leader group in 2005.
- FUNMAT should not be seen as the sole instrument for co-ordination between the major institutions in Norway in the field of nanotechnology. This is due to several factors: first

there are other significant institutions and groups in Norway interesting to co-operate with, even if they are not a part of the FUNMAT consortium. Secondly, nanotechnology covers many areas in which the FUNMAT consortium as such has no interest, and finally FUNMAT deals also with other things than nanotechnology.

5.3 EU initiatives

This chapter gives a short overview over the current and future funding of nanotechnology in Europe. From these general conditions in the European research area some conclusions are drawn for SINTEF's strategy for European networking and SINTEF's strategy towards nanotechnology in FP7.

5.3.1 Future EU-strategy for nanotechnology

The main objectives for FP 7 are published on a web-page about future research in Europe http://europa.eu.int/comm/research/future/index_en.html:

"Six major objectives are identified:

- *Creating European centres of excellence through collaboration between laboratories*
- *Launching European technological initiatives*
- *Stimulating the creativity of basic research through competition between teams at European level*
- *Making Europe more attractive to the best researchers*
- *Developing research infrastructure of European interest*
- *Improving the coordination of national research programmes*

In addition, two new areas for European-level research activities are presented: space and security."

The first three items in this list denote a further fortification of the importance of bigger networks as it could be seen already in FP6 (importance of IPs and NoEs in funding). The last two items denote a growing role of the European Commission also for national research programmes, because of a higher coordination effort and in addition to that the increased budget. A significant higher European research budget is expected to lead to a lowering of national research budgets which makes the participation in EU-projects more and more important for research funding.

The importance of bigger networks can also be seen in the newly introduced concept of European "Technology platforms" (TP). The aim of these platforms is to define a "Strategic Research Agenda" for technology fields with high societal and economical impact on Europe, which require an action on a European level because of the demand of big investment and/or a big critical mass of research personnel. Normally there is no special funding for these networks but collaborative funding instruments might be used (like NoE, IP, STREP) if appropriate. In the field of nanotechnology there are two TPs, one for nanoelectronics and one for nanomedicine. Because of the large involvement of industry in these TPs it is assumed that they might influence the research content of FP7. Therefore, SINTEF should participate in such TPs, also without funding. (source: ftp://ftp.cordis.lu/pub/technology-platforms/docs/tp_report_defweb_en.pdf).

The Luxembourg presidency communicated the following regarding FP7 and nanotechnology (from http://www.cordis.lu/luxembourg/priorities.htm), which emphasises the importance of nanotechnology for the future framework programme:

"The Luxembourg presidency recognises the importance of nanotechnologies for the competitiveness of the European economy and, using the nanotechnology action plan developed by the Commission as its guideline, intends to promote the strengthening of activities in this domain."

The Commission published a communication "Towards a European strategy for nanotechnology" (COM(2004) 338; ftp://ftp.cordis.lu/pub/nanotechnology/docs/nano_com_en.pdf). In Annex .1 the main objectives from this document are listed. They give an indication what kind of topics might be funded in FP7. Some of them are already addressed in the latest work programmes of FP6.

To summarise guidelines for SINTEF's future nanostrategy with respect to the general EU program objectives (Section 9.1 Appendix):

- Important role of the **involvement of SMEs** in nanotechnology research projects; concentration of R&D activities in order to secure **critical mass and synergy** between development of nanotechnologies, related engineering and safety aspects; participation in **roadmap and foresighting** efforts
- Offer of **research infrastructure for the needs of industry** and in particular SMEs (like the MINA-lab) and developing synergy with education; being orientated about the possible building of **European-level nanotechnology infrastructure**
- Taking part in a possible joint **Marie Curie call for nanotechnology**; taking part in a possible "**European award in nanotechnology**" process
- Investigation of perspectives and conditions for **successful industrial exploitation** of nanotechnology; applying for projects which addressing common activities in **regulations, standards, norms and metrology**
- Identify **safety concerns and risks for health and environment** and support the integration of these aspects in early stages of R&D activities together with specific studies
- Be aware that the EU might support **projects with third countries**

5.3.2 European Networking - General recommendation for SINTEF

As pointed out earlier, the new funding instruments IPs and NoEs are becoming more and more important. In addition, an analysis of the allotted projects shows that some "winning networks" exist with a good track record in the EU-system. Therefore, European networking is crucial for a successful participation in EU-projects. Generally, networking can be achieved in different ways:

- Personal contacts
- Promoting SINTEF's technological strengths at conferences, fairs and scientific journals
- Active use of the internet

The first item – personal contacts – can be addressed by various measures. This might include active recruiting of European researchers, internships for students, post-docs, scholarships etc. This might also involve encouraging SINTEF researchers to take part in e.g. the Marie-Curie programme of the EU. Another measure might be the personal visit of relevant potential European partners and presenting SINTEF's technological strengths.

Those potential partners might be identified also at conferences and fairs. Therefore, it is important that SINTEF is actively present with presentations and documents its scientific potential.

SINTEF should also be present in various internet fora. The most important for nanotechnology at a European level is www.nanoforum.org . This should be combined with a good, updated web-page for SINTEF's nanotechnology offers. This page should include a lot of important keywords, so that it is one of the first hits in a web-search.

5.4 Recommendations

- As a basis for sharing Nanolab laboratories, SINTEF should follow up the expectation from NTNU relating to showing financial commitment. To be follow up after the Nanolab business plan has been communicated to SINTEF via the Ad Hoc Committee.

- Be proactive in developing the Gemini centres, CATMAT and at MiNaLab as platforms for the collaboration with UoO SMN within the field of nanotechnology. Recognize MiNaLab as an important infrastructure for nanotechnology in SINTEF Oslo.

- SINTEF must try to become involved in IP or NoE consortiums and wherever feasible, should position itself so as to lead such consortia and take the lead in the writing of such proposals. SINTEF must support its researchers as good as possible at performing such a demanding task.

- SINTEF should get involved in European Technology Platforms that are relevant for nanotechnology, such as Nanoelectronics, Nanomedicine, EuMat and MANUFUTURE which are considered to be of special interest for SINTEF.

- SINTEF should aim at becoming involved in EUs *specific coordination and support activities* (SSA) to prepare for a research agenda and to build the research community in order to define major trends and to address the ICT-bio-micro-nano-technology combined field, their technologies and their applications; emphasizing multi-disciplinarity and addressing research and innovation at the boundaries of different sciences.

- To support the process of proposal writing it might be necessary to obtain funding from NFR or get support/funding from other members of the consortium.

- To enhance the quality of such proposals SINTEF should encourage its researchers actively (for example attractive terms for company leave for the required days etc.) to work as proposal reviewers for the EC and allow those people with experience in proposal reviewing to help produce high quality proposals from SINTEF by carrying out internal reviews of proposals before they are sent.

- Since FUNMAT has achieved national recognition, SINTEF should use FUNMAT actively, both to strengthen relations between the four FUNMAT institutions within functional materials and nanotechnology, and as a lobby instrument.

6 Technology Areas

There are a lot of surveys and publications that describe different areas where Nanotechnology may contribute to develop new possibilities and great enhancement in existing products and processes. Some priority areas described are region specific while others are global or at least more continental oriented. For SINTEF it is very natural to have a special focus on the European marked. Particularly with respect to the EU market, it is important to exploit and be part of this network. The EU market is growing fast and it will be a central arena for research and development within all disciplines in the future.

Although SINTEF performs contract research in most of the major disciplines, the Strategic Working group suggests focusing on areas where SINTEF already has a broad experience and may play a leading role in the research and development of new applications and processes. The limited funding from the Norwegian Research Council for basic research, will rarely set SINTEF in a position to carry out any extensive fundamental basic work, and hence any resources should be earmarked to a selected number of well defined areas.

In order to identify activities and possible strategic key areas within SINTEF, research groups in SINTEF were asked to come up with proposed areas. Furthermore these inputs should be based on predefined (Strategic Work Group, SWG) criteria, application areas and a specific definition of “Nanotechnology” (see Section 3.).

6.1 Proposed strategy for classifiying Nanotechnologies

The SINTEF situation report (SINTEF Report STF24 A04003 Nanotechnology) reveals a considerable level of activity that can be defined within the term “Nanotechnology”. The report gives a coarse overview on resources (manpower and finances) for all general activities, but does not provide details on different resources such as financial, manpower, timeframe, academic and professional network needed for development, production and marketing of specific well defined applications based on SWG’s definition of Nanotechnology.

In the status report (situation report) the application areas were categorised as follows:

- Characterisation
- Modelling
- Carbon nanotubes
- Metals
- Synthesis of inorganic materials
- Material design, surface engineering and nanostructuring
- Hybrids and polymer materials
- Surface modification and applications
- Nanocapsules and emulsions
- MEMs and NEMs
- Nanomaterials for photonics and microwave devices

To be able to get more focus on the application side and to identify the most promising target areas, the SWG proposed an alternative classification of areas, disciplines and application areas than in the status report.

The main 3 classifications were defined as “Particle Systems”, “Bulk Systems” and “Interface Systems”, Figure 6.1. Different divisions, disciplines and application areas are only briefly commented (below) in this strategy document.

Particle Systems:
The focus should be on synthesis, handling, dispersing of nanoparticulate components including emulsions. The final products may be solids, solid-liquid system, liquids, capsules of different shapes and composition. Manipulation of pore structures, sizes and distributions of inorganic and organic particulate systems are essential for the functionality of these materials.

Applications: Surface treatment, coatings, functional liquids or particulate solids.

Bulk Systems:
This implies all forms for nanostructuring of or within “bulk systems”, which normally are solid materials. Included are also porous materials (gas / liquid in a solid material) or structuring of one type of solid compound in another solid material (alloys). Particulates may also be part of a bulk system.

Applications: Catalysis, separations, absorption, functional materials.

Interface Systems:
Typically this is structuring of and on interfaces / boundaries in NEMS and MEMS applications. The applications demand focus on building specific structures on surfaces (Bottom Up or Top Down systems) and manipulation and control of chemical / biological moieties as nanothin films / structure on interfaces. Particulates may also be part of an interface system.

Applications: sensors, biological intelligent systems, micro devices.

In order to receive the input forms in a more uniform and comparable setup, the new disciplines and application areas were defined by the SWG as shown in Fig. 6.1. See Section 9.3, Appendix for pre-made input form, definition of Nanotechnology, different criteria and more general information.

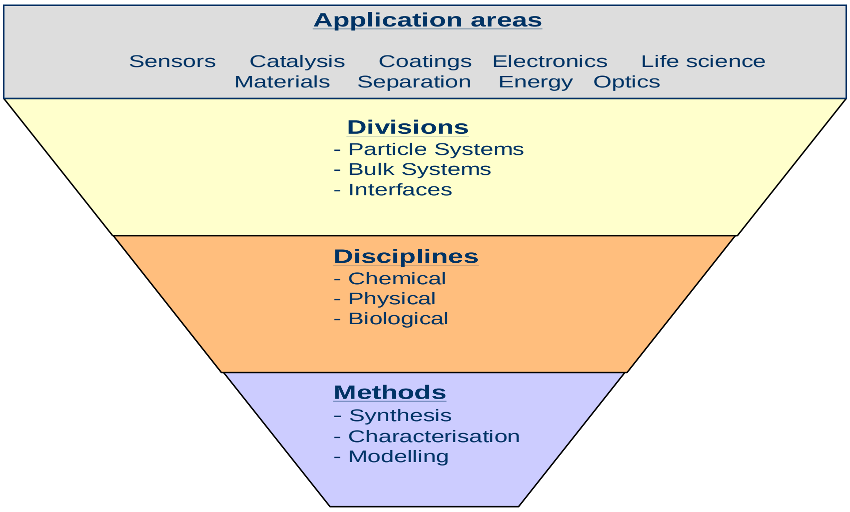


Fig. 6.1 Proposed strategy for classifying nanotechnologies on the basis of methods, disciplines and divisions. Typical examples of potential application areas are given for illustration.

6.2 Evaluation of Input from SINTEF groups

The SWG received a total of 18 input forms representing only two divisions (SINTEF Materials and Chemistry and SINTEF ICT) out of six divisions within the SINTEF Group. There was a great variation in the amount of detail presented and discussed in the input forms, and only 15 forms adequately described the different activities and projects.

Eleven forms described activities within the division of *Particle Systems* (particles / coatings), while activities in the division of *Bulk Systems* and *Interfaces* (MEMs and NEMs) are respectively described in two and five forms. All input forms are shown in Section 9.3, Appendix.

6.2.1 Finance and timeframe

A selection of key information collected from the input forms are presented in Table 6.1. The table shows that there is a requested need for approximately 94 MNOK to totally finance all activities described. Activities within the division *Particle Systems* accounts for 56.6. MNOK while 31.1 MNOK are requested to cover activities within the division of *Interfaces*. No such data can be recovered from the forms describing activities within the Division *Bulk Systems*. Most of the activities and projects are based on part-financing from the Norwegian Research Council, EU network or industry partners. This implies that the requested financial support needed from SINTEF is respectively 31.1 MNOK and 14.6 MNOK.

It should be strongly emphasized that these data are only rough estimates.

Common for almost all projects, it is evident that SINTEF has a very broad and relevant expertise and know-how. In cooperation with NTNU, UoO, industry partners or other domestic and international academic institutions, SINTEF is fully capable to succeed in developing applications within the field of Nanotechnology. However, it is most likely that only a few of these applications may result in industrialisation, mass production and large revenues within a timeframe of 5 to 10 years. Nevertheless, it is very important for SINTEF to find and define niche areas and relevant applications in order to be the most attractive future research partner within Nanotechnology.

It is quite clear that SINTEF is not in the position to finance projects to the order of magnitude 47 MNOK. Strategic resources need to be used, not only for project financing, but also and just as important are resources to maintain and strengthen relationships between SINTEF and various academic institutions (network building).

TABLE 6.1, Selected information collected from the Input forms. The (S) in main column 4 means the resources allocated to SINTEF personal.
Differences between numbers in main columns 4 and 7 represent the financial contribution from research councils and / or industry.

Received Inputs, contributors initials; (appendix nr.)	**Division of area**	**Criteria**				**Required Financing mill. NOK**	**Required Human resources**	**Duration (years)**	**Financing from SINTEF mill. NOK**	**Time to Marked (years)**	**Industry Partner identified**
		1	**2**	**3**	**4**						
Bakteria sensor, BGT, (6.2.1)	Particles / coating	+	+	+	+	3,0 (S), (14,0 tot)	1,5 (MC+ICT) 2 PhD	5	3,0	6 - 7	No
Carbon Nanotubes, BM, (6.2.2)	Particles	+	+	+	+	16,0 (S)	8 (MC)	8	12 ?	8	Yes / No
Polymer nanoparticles in general, LK, (6.2.3)	Particles / coating	+	+	+	+	4,6 (S)	2,3 (MC)	2	2,6	2	Yes
Nano Adhestop, PMS, (6.2.4)	Coating	+	+	+	+	2,0 (S)	1 (MC)	1,5	1,5	6	Yes
Nanocellulose, PMS, (6.2.5)	Particles / coating	+	+	+	+	6,0 (S)	3 (MC)	3	3,0	6	Yes
Advanced coatings, CS, (6.2.6)	Particles / coating	+	+	+	+	7,0 (S)	3,5 (MC)	2	3,5	2	No
Structured surfaces and SAM, RWB, (6.2.7)	Particles / coating	+	+	+	+	3,0 (S)	2,5 ?(ICT+MC)	(2) ?	3,0	5 - 10	No
Nanocomposites - coatings, BT, (6.2.8)	Particles / coating	+	+	+		1,0 (S)	0,5 ? (MK)	(1)?	1,0	2 - 3	Yes / No
Membrane based Chem. sensors, AV,(6.2.9)	Coating	+	+	+	+	3,0 ? (S)	1,5 ? (MC+ICT)	?	1,5 ?	5 - 10	Yes
SUM 1						**56,6**	**25,8**		**31,1**		
Porous Materials, HR, (6.2.10)	Bulk systems	+	+	+	+	?	? (MC+ICT)	?	?	?	Yes / No
Nanolayers, OL, (6.2.11)	Bulk systems	?	?	?	?	?	? (ICT)	?	?	3 – 4	Yes / No
SUM 2						-	-		-		
NEMs-systems, RWB, (6.2.12)	MEMs / NEMs	+	+	+	+	0,8	1 (MC+ICT)	3	0,8	3	No
Functional materials in MEMs -, HR /AV, (6.2.13)	MEMs / NEMs	+	+	+	+	5,0	5,5 ? (MC+ICT)	5	2,5	5	Yes
Photonic crystal based sensors, SN, (6.2.14)	MEMs / NEMs	+	+	+		9,3 (S) (17,3 tot)	5-6 (MC+ICT)	4	2,3	5 - 10	Yes / No
Ferroelectrical RF components,UH, (6.2.15)	MEMs / NEMs	+	+	+	+	4,0	2 ? (MC+ICT)	3 -5	4,0	5	Yes / No
Nanophotonics, SN, (6.2.16)	MEMs / NEMs					Information					
Coupling elements, Nanophotonics, SN, (6.2.17)	MEMs / NEMs	+	+	+	+	10,0 (S)	5 (MC+ICT)	4	5,0 ?	3 - 10	Yes / No
Spreading diffractive elements, LS, (6.2.18)	MEMs / NEMs	+	+	+	+	?	? (MC+ICT)	?	?	2 - 5	Yes / No
SUM 3						**37,1**	**19,5**		**14,6**		
SUM TOTAL						**93,7**	**45,3**		**46,7**		

6.2.2 Divisions and applications

Nano particles
From the input forms, it is clear that Particle Systems are very central in many of the applications described. This is not surprisingly, since nanoparticle systems are a versatile method for introduction of a variety of functionalities. Due to their size, nanoparticles may be used in different ways for example; encapsulation of drugs, oxides, detergents or fragrance in personal sector and the particle surface can be functionalised to adhere to clothes and hair while being invisible in any sense.

The small size is also crucial for manipulation and production of special polymers forming through extreme exothermic reactions. Due to the nanosized droplets it is possible to dissipate heat and control the reaction temperature. In such cases each droplet acts as an individual nanoreactor. Stable nanoemulsions are another area of great importance.

Several of the applications described in the input forms use nanoparticle systems for either encapsulations, increased scratch resistance, strength enhancement or functional coatings of defined thickness (monolayers of particles). Also described is use of nanoparticles as tools for making membranes and for masking when doing lithographic work (pattering). SINTEF Materials and chemistry has already an extensive ongoing activity in production of carbon nanotubes. This work may contribute in development of new materials showing unique properties.

According to the SINTEF Status report in Nanotechnology (SINTEF Report STF24 A04003) and the inquiry by interview in different SINTEF departments and industries, nanoparticle systems are used extensively in development of inorganic materials. SINTEF holds a broad experience in Sol gel technology which is used in preparation of both non-porous and porous zeolite production.

Nanodevices
The input forms also show that SINTEF have established a broad expertise within MEMS/NEMS and materials for photonics technology. In the future, manipulation and control of nanolayers in conjunction with micro-nano devices will be very important. Different types of sensors and sophisticated optical devices might have a big market impact in current and future applications.

The combination of MST (microsystem technology) with nanomaterials and interfaces enables a wide range of new and better sensors, e.g. in the field of chemical and biosensors. Functionalised surfaces might provide new detection methods or enable the miniaturisation of analysis systems (µTAS = micro total analysis system), e.g. by controlling the wetting in microfluidic channels.

Functional nanomaterials can be used for actuation and detection of different physical phenomena in microstructures. From it’s industrial experience in this area (MiNa lab is producing industrial products), SINTEF could achieve quite mature industrially producible solutions by using the interdisciplinary nature of its organisation.

Membrane technology combined with MST could enable new possibilities for bio-medical, chemical and gas-sensors. SINTEF has high competence in both technology fields and in a number of applications.

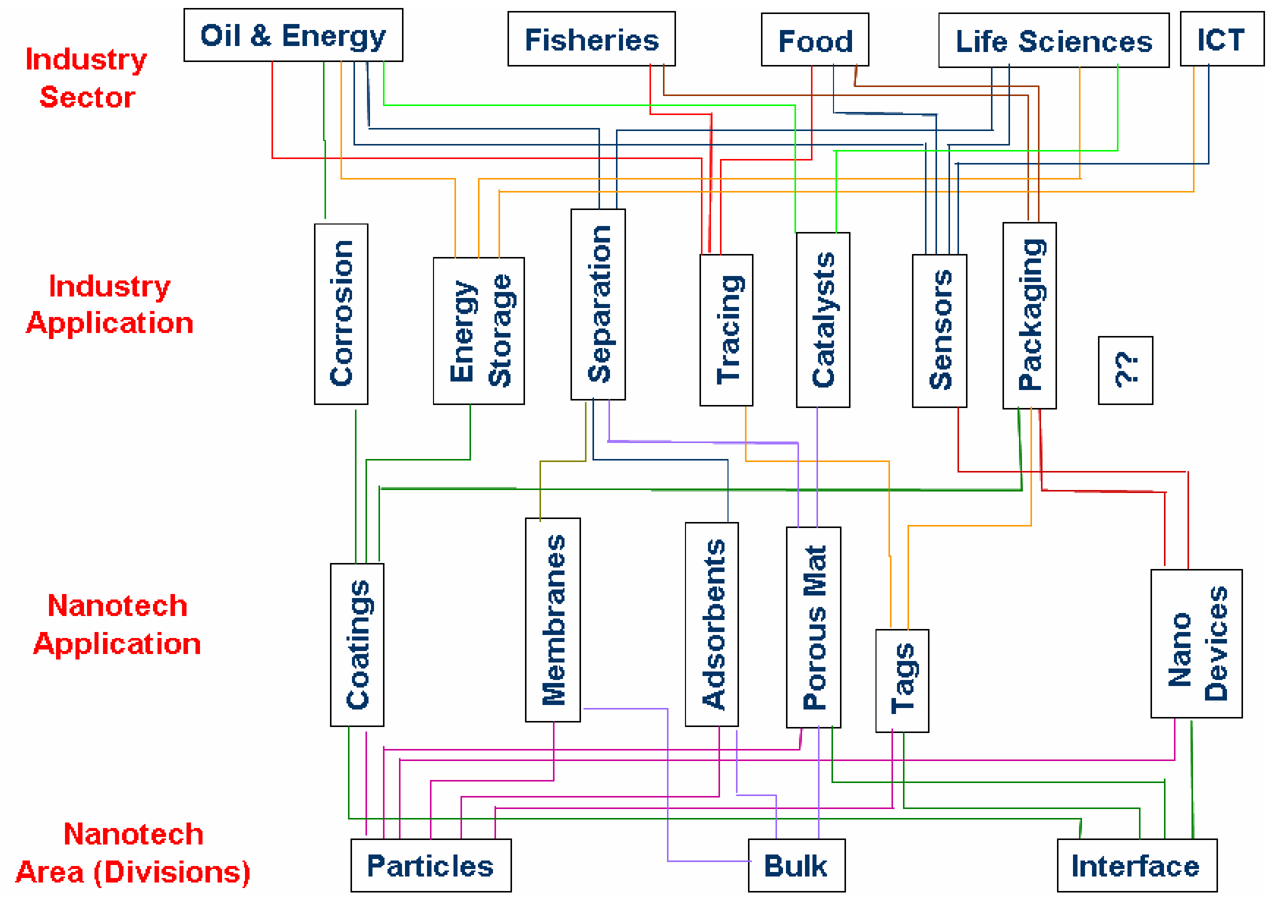
NEMS technology offers a lot of new possibilities because of the small dimensions of the mechanical elements. E.g. new sensors with higher sensitivity and band width can be achieved. In addition, the use of scaling effects of known sensing principles might offer some advantages. SINTEF could support basic research in this area and be a link to industrialisation of results.

Bio-related nanotechnology

Surprisingly, there are only a few input forms describing bio-related nanotechnology without involving nanoparticles. One form describes a new type of bacteria sensor-based on binding of released “pheromones” (oligopeptides), specific for each bacteria strain, followed by detection using quantum dots techniques. Another form describes synthesis of uniformed monolayers of lipids or other bacteria repellent substances for use in implants. The third form describes production and manipulation of nanocellulose fibres.

Manipulation of bio-molecules like proteins, lipids, polysaccharides nucleic acids or other bio-active systems, have been performed through a century, and hence researchers are cautious to promote this as nanotechnology. However, this restraint must not prohibit highlighting of applications which unquestionably are classified as nanotechnology.

The different Nanotech Area (divisions) and Nanotech applications can relate to several industry applications and industry sectors through a number of pathways. Figure 6.2 provides a simple illustration of how core expertise in the three main divisions may be translated through SINTEF activities to industry-relevant applications for.key industry sectors.



Figure, 6.2, Example of a roadmap illustrating how SINTEF can develop industry-relevant applications for key industry sectors from the three core nanotechnology divisions. Note this road-map is not comprehensive.

6.2.3 General interest for nanotechnology in other SINTEF divisions.

Research groups within SINTEF Marine expressed an interest in the use of nanotechnology in marine constructions and in the fishing industry. Intelligent fishing nets and constructions which can resist corrosion and degradation are of special interest. However, none of these applications are expressed in input forms or ongoing activities.

Through a variety of sources the SWG is aware that there is also an interest for Nanotechnology within SINTEF Health. No input forms were received from this division, but special interest for clothes capable of monitoring functions such as body temperature, pulse and heart rate have been discussed. Fig. 6.2 schematically shows different correlations between divisions, application areas and types of “industry”.

6.3 Overview of equipment infrastructure requests from SINTEF groups

The institutes of Materials & Chemistry and ICT have provided input with respect to investment needs for infrastructure / instrumentation related to nanotechnology of a total amount of 82.3 MNOK. This covers requests for equipment for siting in Trondheim and Oslo sites, covering the application areas of Characterisation, Synthesis and “Structuring”. Taking into account instruments that are currently being purchased (CVD, PLD, XPS and AES, etc), and duplication of major instrumentation that has been requested from the two SINTEF sites, this total is reduced to an outstanding financing needs of ca 35 - 40 MNOK.

A detailed breakdown of the equipment requests is presented in Table 6.2 and a complete summary of the infrastructure request is given in Appendix 9.4. This table shows a nominal total for the costs of the requested equipment and minimum / maximum totals depending on a variety of factors.

Based on the input that has been received, the following recommendations have been made:

- The equipment requests/needs should be integrated into the strategy process and should be considered in the light of the investments to be made in the NTNU nanolab.
- A strategy for best developing and improving expertise within optical characterisation techniques should be implemented.

TABLE 6.2, Overview of nanotechnology equipment infrastructure received from groups in SINTEF Materials & Chemistry and ICT.

Characterisation Equipment Needs	Nominal	Potential Reduction	Potential Increase
AES	6 000 000	0	2 000 000
TEM Tomography	600 000	-50 000	50 000
ToF-SIMS / nanoSIMS	7 500 000	-1 500 000	1 500 000
Optical near field microscopy	1 000 000	-300 000	500 000
Raman / Imaging raman	500 000	-200 000	500 000
AFM scanner	100 000	-20 000	50 000
Temperature control for AFM	300 000	-50 000	100 000
AFM in TEM-holder	500 000	-200 000	500 000
XPS	6 000 000	0	2 000 000
Raman / SFG Spectroscopy	2 500 000	-500 000	500 000
Updated NMR	2 000 000	-300 000	300 000
Ellipsometry	2 000 000	-1 000 000	500 000
Wear test equipment	200 000	-100 000	300 000
Wetting properties	80 000	0	10 000
Char. Equip. for microporous membranes	500 000	-50 000	50 000
Permporometry	1 500 000	-100 000	200 000
Single-crystal XRD	2 500 000	-500 000	500 000
Upgrade of existing XRD	1 000 000	-500 000	200 000
Sum (Nominal, Minimum, Maximum)	34 780 000	29 410 000	44 540 000

Synthesis and Structuring Equipment			
Dip Coater	130 000	-10 000	10 000
Ultracentrifuge	300 000	-200 000	200 000
FIB installation in existing SEM	4 000 000	0	0
Direct Nanoparticle Deposition	2 000 000	-500 000	500 000
RTP	100 000	100 000	100 000
CVD	5 750 000	0	0
Pulsed Laser Deposition	7 750 000	0	0
Metallisation e-beam/sputtering	2 000 000	-500 000	100 000
Plasma deposition	2 000 000	-500 000	100 000
Plasma etching processor	2 000 000	-500 000	100 000
FIB/SEM	7 000 000	-1 000 000	2 000 000
Etching / sputtering possibilities for polymers	2 000 000	-500 000	100 000
Lithography	2 000 000	-1 000 000	100 000
Deposition / etching of transparent electrodes	4 000 000	-3 000 000	100 000
Liquid Crystal - ferroelectric fluids	500 000	-200 000	200 000
Optical coating, MgF2	2 000 000	-500 000	100 000
Ashing	1 500 000	-500 000	100 000
implantation	1 500 000	-500 000	500 000
H2 loading cell	500 000	-400 000	200 000
Laser ablation for polymer structuring	500 000	-50 000	50 000
Sum (Nominal, Minimum, Maximum)	47 530 000	37 770 000	52 090 000
Total (Nominal, Minimum, Maximum)	**82 310 000**	**67 180 000**	**96 630 000**

6.4 Recommendations

It is evident that expertise especially within SINTEF M&C and SINTEF ICT covers a range of areas, including:

- organic and inorganic polymer systems
- porous and nonporous particle systems
- membranes
- nanocarbontubes and fibres
- coating techniques
- chemical functionalisation and structuring of surfaces
- nanodevices and sensors based on silicon technology (MEMS/NEMS)
- functionalised surfaces and nanoporous membranes;
- nanophotonic and nanooptical devices

However, a few areas are more conspicuous than others.

- In order for SINTEF to play a leading role in Nanotechnology and in particular in nanoparticulate systems, it is crucial that all the unique competence and expertise within the different divisions and departments are made use of and that interdisciplinary collaborations are emphasized and strengthened.

- This competence may be used in development of systems for controlled release of different components, coatings, catalysts, and new smart nanomaterials. Although catalysts and nanomaterials in general (composites included) have not extensively been addressed in the input forms, the SWG believes these areas are very important.

    - This potential may be realized through establishing a market project.

- There should be a special focus within the development of new sensors (including biosensors) or other types of intelligent chemical and electronic devices, and this should be organised in order to take advantage of the huge potential in combining technology and expertise from different divisions in SINTEF. In combination with this nanostructuring of devices, it will be important to implement “intelligent” nanoparticles, ultra-thin films (use of e.g. CVD and PLD) and tailor-made molecules (biomolecules).

Despite a modest feedback within bio-related applications, the SWG believes this is an important area, and hence effort to reveal such applications should get attention.

- Initiate a process to identify possibilities especially within SINTEF’s biorelated departments.

7 HES and ethics

Health, Environment, Safety (HES) and Ethical issues are increasingly being considered to be important aspects of Nanotechnologies that must be thoroughly accounted for when such technologies result in products that become widely available. As for all previous rapidly emerging technologies which are perceived to have potentially wide-reaching impact on society (Biotechnology, etc), potentially negative aspects/views of innovative developments need to be evaluated and seen to be handled in a responsible manner.

These aspects of Nanotechnology have been rapidly identified by most of the major funding organisations, both nationally and internationally and a number of reports have been published with recommendations. Two examples are "Nanotechnology and new materials: health, environment, ethics and society", commissioned by the Norwegian Research Council, Committee for ethical research in science and technology and the Technology Council, and "Nanosciences and Nanotechnologies: opportunities and uncertainties", commissioned by the Royal Society and Royal Academy of Engineering. In general, recommendations involve the independent monitoring of the potential negative impacts of developments in this area and the funding of research into development of standards for measuring and monitoring.

The HES consequences of Nanotechnologies can in general be considered at two levels:

- Known and potential health and safety aspects involved in the development and integration of Nanotechnology in to commercialisable products in the near term
- Potential and unknown health, environmental and safety aspects in the long term developments.

The former to a great degree concerns the health and safety aspects related to nanoparticulate systems due to their current short time to market and their potential for being dispersed within the environment and the body. These concerns must thus be addressed, including:

- Work and safety practices for handling these systems during development and manufacture
- Health and safety of integration of these systems into products
- Health and environment consequences of dispersion of these systems into the environment

The latter concerns the unknown consequences of the development of complex systems with innovative functionality, the most worrying scenarios relating to self-replicating "nanodevices".

With respect to addressing the "non-technical" aspects in relation to nanotechnologies, the term ELSA (Ethical, Legal,and Social Aspects) is being used increasingly internationally to address these social scientific perspectives. Thus in realising SINTEF's vision "Technology for a better society" through a broad-based form of interdisciplinary research, consideration should also be given to integrating nanotechnological research with social science and humanistic research. SINTEF possesses ELSA expertise linked, among other things, to research within the interdisciplinary knowledge-based field *Technology and science studies;* better known as STS (Science and technology studies). This not only encompasses methods for investigating various technologies within a wider societal context, but also addressing concrete technology development processes

There are four areas in particular within which STS expertise can be important in relation to SINTEF's strategy:

– Knowledge of the innovation processes themselves, particularly the role customer-relations has as a driving force for new thinking. Studies of the politics of research are also central in order to understand innovation.

– Knowledge of attitudes to new technology. Here the line between “natural” versus “artificial”, is often the basis for opposition to new technology. However, unfettered technological optimism lays the basis for unforeseen development of “hype” in the form of irresponsible presentation of the possibilities linked to new technology.

– Knowledge of society’s and research’s means of relating to uncertainty. The STS perspective overshadows risk-thinking’s need of seeing the potential danger signals beforehand, and is to some extent more proactive than the precautionary thinking.

– International relations particularly linked to observation of technological trends and more generally to networks and research cooperation; especially with respect to the EU’s framework program.

Within these four areas nanotechnologies provide special possibilities, as well as challenges for social scientific research. However, the organisation of research often results in that societal perspectives become a separate “piece” that comes in addition to the technical research. This is often in contrast to the intentions of integration. Thus, compared to other research centres, SINTEF, within the same organisation, has a unique possibility of integrating societal perspectives at the project level.

7.1 Recommendations

- Considering the increasingly documented concerns regarding HES and ethics of Nanotechnology, it is recommended that SINTEF’s strategy and practice of Nanotechnologies should take the lead with respect to its customers and partners in evaluating and identifying potential HES and ethical impacts wherever practical.

- SINTEF should aim to be involved in the relevant fora, both National and International, within which standards, work practices and guidelines are to be developed.

- It is recommended that a review of current and planned activities within nanoparticles is carried out and where necessary, preliminary guidelines established.

- SINTEF, should make use of its unique constellation of expertise to establish mechanisms and finance to support integrating societal perspectives at the project level.

8 Recommendations

8.1 Prioritised Areas

SINTEF has strong expertise within a number of basic technology platforms.
The SWG recognises these technology platforms as already established or being developed under strategic activities or industry financed projects.

- SINTEF's strategic efforts within the field of nanotechnology should be focused on developing applications and products mainly based on established technology platforms.

- In order for SINTEF to play a leading role in nanotechnology and in particular in **nanoparticulate systems**, it is crucial that all the unique competence and expertise within the different divisions and departments are made use of and that interdisciplinary collaborations are emphasized and strengthened.

- This competence may be used in development of systems for controlled release of different components, coatings, catalysts, and new smart nanomaterials. Although **catalysts** and nanomaterials in general (composites included) have not extensively been addressed in the input forms, the SWG believes these areas are very important.

- There should be a special focus within the development of **new sensors** (including biosensors) or other type of intelligent chemical and electronic devices, and this should be organised in order to take advantage of the huge potential in combining technologies and expertise from different divisions in SINTEF. In combination with these nanostructured devices, it will be important to implement "intelligent" nanoparticles, ultra-thin films (use of e.g. CVD and PLD) and tailor-made molecules (biomolecules).

- Despite a modest feedback within **bio-related applications**, the SWG believes this is an important area, and hence effort to reveal such applications should get attention.

8.2 Key recommendations

One of the most attractive features of Nanotechnologies is the interdisciplinary opportunities; thus SINTEF should give priority to those areas where this interdisciplinary potential can be realised and maximise opportunities where SINTEF has the greatest strengths. With respect to this the following recommendations are given:

1. A proactive mechanism should be established to increase the awareness and knowledge of the industry within in the field of Nanotechnology. SINTEF could have an important role in identifying Nanotechnology developments that are relevant for industry, and to facilitate adoption of Nanotechnology in future industrial products.

   Action: **A "Technology Scouting"** program should be set up immediately, with initial internal funding. The Norwegian Research Council and industry partners that have signalled interest during the SWG interview process are to be contacted to establish additional funding mechanism. Site visits to all relevant industry, in the form of focussed workshops and demonstrations should be completed during 2005.

2. SINTEF ICT and SINTEF Materials and Chemistry represent core disciplines for innovation with Nanotechnology and this is already represented in a number of projects, programs and developments in a variety of key Nanotechnologies. Though the opportunities of synergy between the two units are already being implemented in a number of projects, the critical role of these two units should be given a clear focus.

3. Action: **A kick-off workshop** between the two units should be organised, focussing on the prioritised areas, with group-work generating at least two concrete **cross-disciplinary project proposals** including recommended proof of concepts and financing strategy. These projects should focus on developing the industrial potential based on in-house technology platforms in order to generate IPR and put SINTEF in the position as a attractive collaboration and development partner.

   Opportunities for project proposals that have potential application within "bio-nanotechnology" should be reviewed to position SINTEF within this key area.

4. As a means for establishing a closer relationship and interaction between groups working in fields with potential relevance for Nanotechnology, a mechanism for co-locating and/or co-hosting of relevant groups in each others laboratories should be established.

   Action: At least one annual **co-location/hosting** activity should be implemented, commencing with 2005, linked to the projects initiated from 1 – 3 above.

8.3 Infrastructure and Work practice recommendations

Considering the increasingly documented concerns regarding HES and ethics of Nanotechnology, it is recommended that SINTEF's strategy and practice of Nanotechnologies should take the lead with respect to its customers and partners in evaluating and identifying potential HES and ethical impacts wherever practical.

5. SINTEF should become involved in the relevant programs, both National and International, within which standards, work practices and guidelines relating to HES and

Ethics are to be developed. SINTEF should also establish a mechanism for reviewing of current and planned activities and establish guidelines where relevant.

Action:

- One representative from SINTEF ICT, SINTEF Material and Chemistry and SINTEF Technology and Society to develop strategies, proposals for projects to support ELSA components in development programs and engage SINTEF within National and EU programs related HES and ELSA.
- A review of HES issues relating to current activities, in particular nanoparticles should be implemented as soon as possible.

NTNU and the UoO are SINTEF's important strategic partners and all mechanisms for interaction and dialogue with respect to strategies and developments in Nanotechnology should be actively pursued. To ensure appropriate engagement of SINTEF with both partners, particularly with respect to optimal use of infrastructure, the following recommendation is given:

6. As a basis for sharing Nanolab laboratories, SINTEF should follow up the invitation from NTNU relating to showing financial commitment. To be followed up after the Nanolab business plan has been communicated to SINTEF via the Ad Hoc Committee. The financial commitments related to such an involvement has to be treated separately, and is not regarded as a part of the budget proposed in chapter 8.5 of this document.

7. SINTEF should promote the concept of an "independent" infrastructure for prototyping and/or small scale production of components or materials based on nanotechnology.

8. SINTEF shall be proactive in developing the newly established Gemini centres CATMAT and MiNaLab as a platform for the collaboration with UoO SMN within the field of nanotechnology and recognize MiNaLab as an important infrastructure for nanotechnology in SINTEF Oslo.

9. Since FUNMAT has achieved national recognition, SINTEF should use FUNMAT actively, both to strengthen relations between the four FUNMAT institutions within functional materials and Nanotechnology, and as a lobby instrument.

8.4 General Recommendations

It is important for SINTEF to be represented in all the major accessible funding programs relating to Nanotechnology and actively look to translate this to applications that can be the basis for engaging industry. With respect to this the following recommendations are given:

10. The Norwegian research council has now started to support industrial projects within the NANOMAT programme. This kind of funding is expected to be continued in the next years of the programme, because the main part of the funding before was for basic research projects.

    Action: SINTEF should use this opportunity and **find industrial partners**, who would like to participate in such projects. This should be done in combination with the action in the next item.

11. SINTEF should strengthen and coordinate its strategy for soliciting support from the 6th and 7th framework programs, to maximise the success rate for this crucial source of funding for Nanotechnologies R&D.

Action

- Become involved in IP or NoE consortiums and wherever feasible, should achieve lead positions in the consortia and writing of proposals. SINTEF must support its researchers as much as possible in performing such demanding tasks.
- Be a partner in defining the technology platforms for 7th framework program
- SINTEF should aim at becoming involved in EUs *specific coordination and support activities* (SSA) to prepare for a research agenda and to build the research community in order to define major trends.
- Obtain funding from NFR or get support/funding from other members of the consortium to support the process of proposal writing it if feasible.
- Actively encourage its' researchers (for example attractive terms for company leave for the required days etc.) to work as proposal reviewers and allow those people with experience in proposal reviewing to help produce high quality proposals from SINTEF by carrying out internal reviews of proposals before they are sent.

8.5 Budget

Preliminary budget for SINTEFs strategic efforts within nanotechnology for the **first 12 months** is found below. These activities should be financed through basic grants (SEP) and internal funding from the groups involved. A "Konsernsatsning" is proposed to cover the activities described in the budget below.

Strategic Activity	Budget
Establishing a technology scouting program	200 kkr
Kick-off work-shop	500 kkr
Strategic interdisciplinary project 1	2000 kkr
Strategic interdisciplinary project 2	2000 kkr
Co-hosting	500 kkr
Supporting ELSA components	300 kkr
SUM	**5500 kkr**