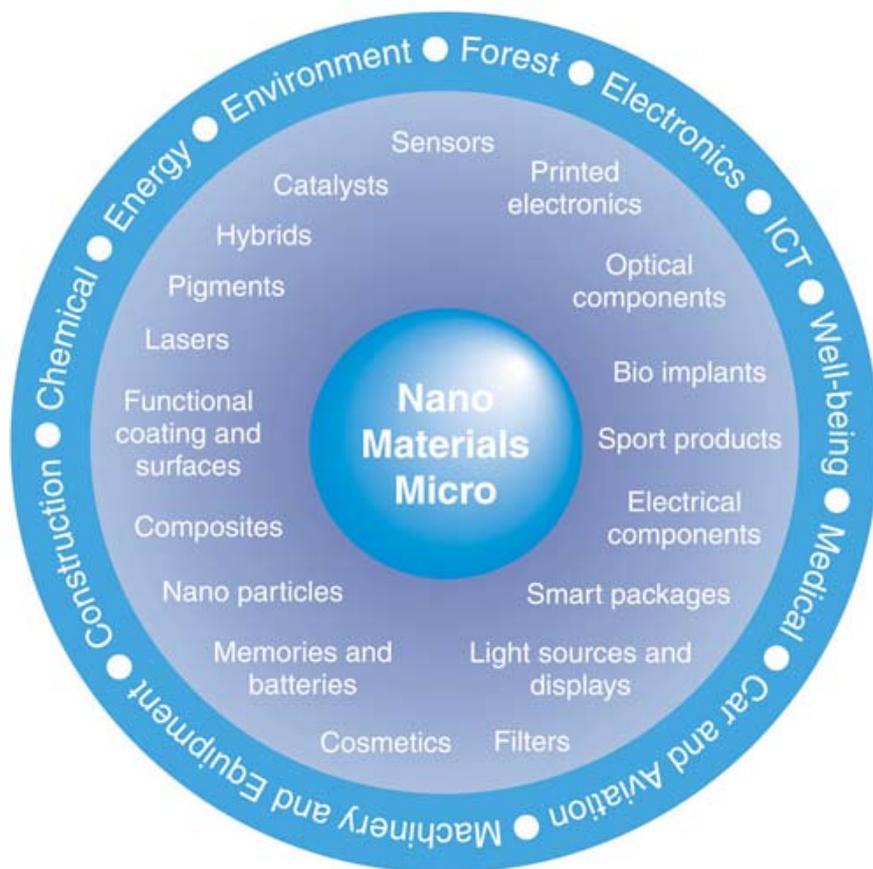


# Nanotechnology Cluster Programme 2007 – 2013



## VISION 2013

Finland has become one of the key EU centres of applied research and business related to nano- and microtechnologies and new materials based on them.

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## SUMMARY

The parties to the Nanotechnology Cluster Programme are leading internationally networked research bodies studying nano- and microtechnologies and future materials based on them, world-class companies utilising expertise in these areas and others working to become such companies, and seven Finnish Centres of Expertise that are networking this expertise and the development of co-operation: the Helsinki Region, the Jyväskylä Region, the Kokkola Region, the Mikkeli Region, North Karelia, the Oulu Region and the Tampere Region. Together these seven Centres of Expertise have compiled this strategic Nanotechnology Cluster Programme, and each of the centres has committed to implementing the chosen strategy.

The technological core of the Nanotechnology Cluster Programme consists of nano- and microtechnologies and future materials based on them. The expertise associated with this core can be applied to an extremely broad range of intermediate and end products that are utilised in different industrial and business sectors. The key application areas in this cluster programme are the following technology industries: the electronics and electrotechnical industry, the mechanical engineering industry and metal refining, the information technology sector and health technology. Other important sectors for this cluster programme include the forest industry, the chemical industry, the plastics industry and the construction industry. In addition, energy and environmental technology applications will be important. The chosen application areas are strategically important, as demonstrated by the Science and Technology Policy Council of Finland's proposal regarding the first Strategic centres for science, technology and innovation: the forest cluster, metal products and mechanical engineering, information and communication industry and services, energy and the environment, and health and well-being.

The importance of nano- and microtechnologies in terms of the competitiveness and profitability of companies will grow strongly in the future. The core of the cluster programme's actions is to transfer top research expertise to business activities – more effectively and faster than is being done at present. This requires small and medium-sized technology companies that are innovative, growth-oriented and capable of growing, as well as large companies that market mass products globally, to ensure that reaching markets can occur as fast as possible. To develop the business operations of SMEs it is important that they become partners of large companies, in Finland or globally.

Nanotechnology is the youngest part of the cluster and requires the most resources considering the length of the entire programme up until 2013. Microtechnologies have been applied for a long time, but there is still room to improve them for at least a decade. Future materials are based increasingly on nanotechnology solutions in particular. The influence of nanotechnologies as a multi-disciplinary field combining physics, chemistry and biology will extend to products in all areas of business and to our everyday lives. Approximately EUR 5 billion of government funding and EUR 6 billion of corporate funding were spent on R&D worldwide in 2007. The largest investments are made in the USA, Japan, the EU and China.

The task of the cluster programme is to help Finland remain globally competitive in the profitable utilisation of nano- and microtechnologies. According to the vision of the cluster programme for 2013, "Finland has become one of the key EU centres of applied research and business related to nano- and microtechnologies and new materials based on them." The success of the programme will be measured quantitatively according to the following targets: strengthening of expertise and new forms of co-operation; increasing business and employment based on expertise; and enhancing international activities and attractiveness. During the period of the cluster programme the number of companies utilising the programme's technologies is expected to more than double and the number of SMEs to even quadruple. If successful the cluster programme will accelerate the development of the industrial nanocluster in Finland.

The actions of the cluster programme are divided into two strategic areas: networking and co-operation, and key projects. The key projects will be implemented according to the following themes: technology and forest industry applications; chemical, plastics and construction industry applications; energy and environmental technology applications; the development of generic technology and its applications; business activation, pilot factories and technology transfers especially to SMEs; increasing the global business of companies; characterisation and safety. These strategic actions create added value that will be needed in order to achieve a significant change from regionally centred activities to national co-operation. Another key change will be the increase in international activities, both from Finland outwards and to Finland inwards.

## FOREWORD

The Nanotechnology Cluster Programme is part of Finland's national Centre of Expertise Programme. The Centre of Expertise Programme (OSKE) is a special fixed-term Finnish Government programme to focus work on specific areas of national importance. The concept of the programme is to utilise the international-level expertise in Finland's regions. The Clusters and Centres of Expertise participating in the programme are expected in partnership with other Strategic Centres to continuously improve conditions for internationally competitive and attractive innovation environments in Finland.

The operations model of the programme was reformed for the term 2007–2013 as a cluster-based model, the overriding objective of which is to increase regional specialisation and to strengthen cooperation between Centres of Expertise. Each cluster gathers together the key actors within the regional Centres of Expertise to co-operate in order to implement the cluster programmes. In autumn 2006 the Finnish Government approved the objectives of the national Centre of Expertise Programme in accordance with the Regional Development Act (602/2002). The realisation of these objectives will be monitored annually and through the interim and final evaluation of the programme in 2010 and 2013. The activities of the Clusters and Centres of Expertise will emphasise internationality, attractiveness and accelerating the growth of expertise intensive SMEs. The goal is to create the conditions for new and more diverse forms of innovation activities in which top research expertise is coupled with technological and business expertise. Regional co-operation between business and research remains the foundation of the programme, but the emphasis of operations is much more on national and international networking.

On the basis of a two-phase competitive tendering, the Finnish Government appointed 13 Clusters and 21 Centres of Expertise to implement the programme. The Nanotechnology Cluster Programme is one of the 21 clusters selected by the Finnish Government on 7 December 2006 and includes the following Centres of Expertise: the Helsinki Region, the Jyväskylä Region, the Kokkola Region, the Mikkeli Region, North Karelia, the Oulu Region and the Tampere Region. Together these seven Centres of Expertise have compiled this strategy on the Nanotechnology Cluster Programme, and each of the centres has committed to implementing the chosen strategy.

Within the Centres of Expertise the programme is based firmly on the strengths of each region and on co-operation between companies, universities, research institutes and science parks. The new cluster model offers an excellent opportunity to utilise resources more effectively and to link the regions together even closer to implement Finland's national innovation policy. On the national level the Centre of Expertise Programme is co-ordinated by a multi-disciplinary Centre of Expertise Committee appointed by the Finnish Government. The Committee is assisted by the Secretariat with experts representing the Ministry of the Employment and the Economy, the Ministry of Education and the Finnish Funding Agency for Technology and Innovation (Tekes).

## 1. INTRODUCTION

The core of the Nanotechnology Cluster Programme consists of nano- and microtechnologies and future materials based on them. Nanotechnology refers to the methods used to manufacture materials and structures whose size is measured in nanometres (one billionth of a metre) and that possess properties that cannot be achieved using “old” technologies. Microtechnology refers to a set of methods used to manufacture extremely small structures and components with a precision of even less than one micrometre (one millionth of a metre). Future materials refer to new materials that are based on the use of nano- or microtechnologies and that possess properties that current materials do not have. The expertise associated with this core can be applied to an extremely broad range of intermediate and end products that are utilised in different industrial and business sectors. The examples presented in Fig. 1 already exist or will do so in the near future.



*Fig. 1: The cluster's key technologies, the products based on them, and industrial sectors that can utilise them.*

Finland's national strategy is to succeed in international competition through innovative business activities based on expertise. The importance for the competitiveness and profitability of companies of research and expertise in nano- and microtechnologies and applying them is growing strongly. A particular area of development is the transfer of research expertise to business activities – more effectively and faster than is being done at present. This requires small and medium-sized technology companies that are innovative, growth-oriented and capable of growing, as well as large companies that market mass products globally, to ensure that reaching markets can occur as fast as possible. To develop the business operations of SMEs it is important that they become partners of large companies, in Finland or globally.

### Industry needs to be regenerated

Approximately 150 companies in Finland currently apply or are exploring ways of applying the technologies in the core of this cluster. However, the utilisation of the technologies of this cluster will become important for a much broader group of companies, for example Finnish technology industry companies. There are currently around 800 of these employing directly approximately 270,000 people and indirectly approximately 600,000 people. This represents around 25 percent of the entire Finnish labour force. The combined revenues of the technology industry in 2007 amounted to approximately EUR 70 billion. The technology industry was responsible for 75 percent of Finnish R&D investments and 60 percent of Finnish exports. Key technology industry sectors include: the electronics and electrotechnical industry, the mechanical engineering industry and metal refining, the information technology sector and health technology. Other important sectors for this cluster programme include the forest industry, the chemical industry, the plastics industry and the construction industry. In addition, energy and environmental technology applications will be important. The chosen application areas are strategically important, as demonstrated by the Science and Technology Policy Council of Finland's

proposal Strategic centres for science, technology and innovation: the forest cluster, metal products and mechanical engineering, the information and communication industry and services, energy and the environment, and health and well-being.

**Development of nanotechnology is actual**

Nanotechnology is the youngest part of the cluster and requires the most resources considering the length of the entire programme up until 2013. Microtechnologies have been applied for a long time, but there is still room to improve them for at least a decade. Future materials are based increasingly on nanotechnology solutions in particular. The influence of nanotechnologies as a multi-disciplinary field combining physics, chemistry and biology will extend to products in all areas of business and all aspects of our lives. Approximately EUR 5 billion of government funding and EUR 6 billion of corporate funding were spent on R&D worldwide in 2007. The largest investments were made in the USA, Japan, the EU and China.

The objective of the EU’s nanoscience and nanotechnology action plan is to increase R&D investments in nanotechnology, to create world-class infrastructures in Europe and to support multidisciplinary nanotechnology research and education, enterprise and industry. The European Commission is encouraging Member States to invest in R&D centres and joint projects and networking between research institutes and companies, as well as to support the innovation activities connected with new technologies and the transfer of technology. Over EUR 3 billion has been budgeted for research into nanoscience, nanotechnology, materials and new production technologies between 2007-2013 within the EU’s Seventh Framework Programme.

The development of nanotechnology is approached from two directions. According to the evolutionary “top down” principle, microtechnology is gradually scaled down into nanotechnology (under 100 nm). According to the revolutionary “bottom up” principle, entirely new structures (including materials) and manufacturing processes are created by applying top science (so-called self-assembly, as in biology). The “top down” approach has already created globally and in Finland new technology companies and new industrially applicable products and production processes. In the long term “bottom up” technology is expected to revolutionise production methods in many areas.

The road from research to end product can be long and expensive, and the resources of start-up or SME are often insufficient to bring the product to global markets profitably. At the same time, spearhead companies that already operate in global mass markets are not always sufficiently aware of the opportunities available by applying the latest technology to their own products. New forms of close co-operation between research, SMEs and large companies play a central role in growing the business of companies within this cluster. Through joint research projects, small and innovative companies can develop intermediate products or components that larger companies can utilise in their own products and bring to market. Fig. 2 presents the value chain of business based on nanotechnology and various areas of expertise connected.

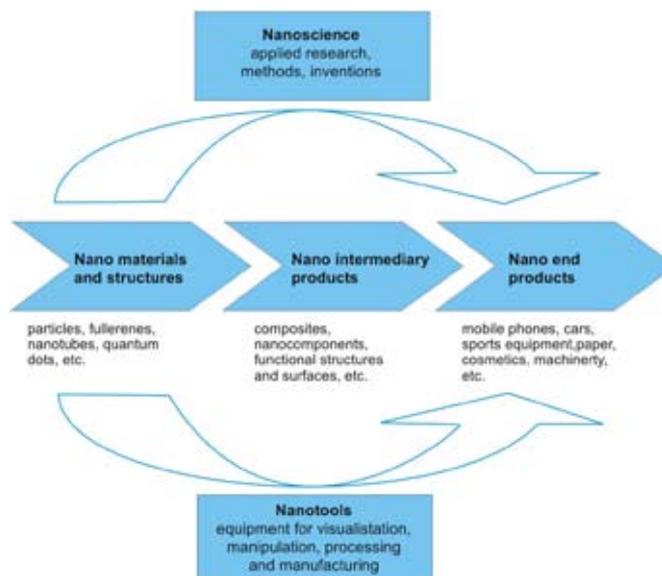


Fig. 2: The value chain of nanotechnology.

**Parties to the cluster programme**

The parties to the Nanotechnology Cluster Programme are leading internationally networked research bodies studying nano- and microtechnologies and future materials, world-class companies utilising expertise in these areas and others working to become such companies, and Centres of Expertise that are networking this expertise and the development of co-operation (Fig. 3).

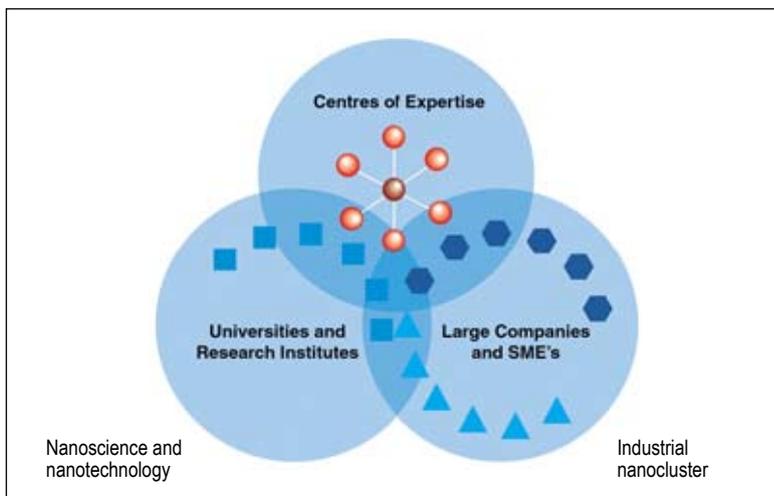


Fig.3: Parties to the Nanotechnology Cluster Programme

Centres of Expertise

The Nanotechnology Cluster Programme is being implemented by seven Centres of Expertise whose implementation companies and key expertises are described below.

Table 1: The cluster programme's Centres of Expertise, implementing companies and areas of key expertise.

Centre of expertise	Companies responsible for implementation	Areas of key expertise
Helsinki Region Centre of Expertise	Culminatum Ltd Oy	Nano- and microsystems, international clusters
Jyväskylä Region Centre of Expertise	Jyväskylä Innovation Ltd	Nanotechnology, especially functional and self-organising nanostructures
Kokkola Region Centre of Expertise	Technology Centre KETEK Ltd	Industrial chemistry applications
Mikkeli Region Centre of Expertise	Mikkeli Technology Centre Ltd	Thin film coatings and plastic composites
North Karelia Centre of Expertise	Joensuu Science Park Ltd	Photonics, material and precision technologies
Oulu Region Centre of Expertise	Oulu Innovation Ltd / Micropolis Ltd	Multitechnical integrated micro- and nanotechnology products
Tampere Region Centre of Expertise	Technology Centre Hermia Ltd	Photonics and advanced materials

The key areas of expertise of the Centres of Expertise and their network partners are presented in more detail in Chapter 5. Top expertise is primarily found in research institutes and universities, but in the future increasingly also in companies.

### Research institutes and universities

The cluster covers over 90 percent of the leading research groups in Finland that are active in nanotechnology, among them Helsinki University of Technology, the University of Helsinki, Tampere University of Technology, Lappeenranta University of Technology, the University of Jyväskylä, the University of Oulu, the University of Joensuu, and VTT Technical Research Centre of Finland. In addition, several polytechnics also belong to the network.

### Companies

Companies that participate in regional or national activities organised by the Centres of Expertise are counted to belong to the cluster programme. Some companies already have products on the market that utilise the cluster's technologies, others are active in R&D, and others are interested in finding out how the new technologies can be utilised in their own business. It is particularly important that small and medium-sized companies at the beginning of the value chain are attracted to participate in the cluster's activities; SMEs that are actively developing new technologies can be world-class experts within a very narrow niche. They often lack the resources, however, to introduce mass production and develop global operations. In addition to SMEs, large companies that market mass products globally are needed to ensure that reaching markets can occur as fast as possible. The cluster programme helps SMEs network with large companies and venture capitalists in order to find the right partners and distribution channels. The goal is for the number of innovative SMEs to increase significantly during the period of the programme.

### **Innovations from expertise**

Identification of business opportunities and development of business expertise within SMEs is central to the success of the cluster's activities. All of the responsible implementing companies selected by the Centres of Expertise are in practice science parks that offer comprehensive business and business skill development services. These begin with evaluating business ideas and end with pursuing growth through internationalisation. These services are supplied by the implementing companies themselves or by a network of partners working in close co-operation. The network also includes public and private partners offering grants and capital funds. The cluster programme offers good and confidential contacts to these tested business development services. However, resources are not used in the Nanotechnology Cluster Programme to develop and fund basic skills in business expertise, as other channels and funding is available for this purpose.

Although the Centres of Expertise act primarily within their own economic regions, the central principle of the cluster programme is that the services of all the Centres of Expertise and research organisations are available to all companies regardless of their location.

## 2. GOALS OF THE CLUSTER PROGRAMME

### 2.1 Mission of the cluster programme

The task of the Nanotechnology Cluster Programme is to support that Finland remains globally competitive in the profitable utilisation of nano- and microtechnologies. The mission of the cluster programme is as follows:

To accelerate and strengthen the development of nano- and microtechnologies and future materials utilising them, as well as the profitable utilisation of these by Finnish companies.

This mission will be implemented by networking and activating co-operation between the various parties:

- The activities are based on developing regional strengths and combining these into a national strength.
- The best research and technology expertise, as well as business partners from across Finland and even globally, are sought for companies within the region of each Centre of Expertise.
- The right companies and research partners from across Finland and even globally are sought for research organisations within the region of each Centre of Expertise.
- Developing the value chains of large companies that manufacture and market mass products globally and SMEs that develop new technologies is essential.

### 2.2 Vision of the cluster programme

The vision of the cluster programme for 2013 is as follows:

Finland has become one of the key EU centres of applied research and business related to nano- and microtechnologies and new materials based on them.

The realisation of this vision is supported by the fact that the cluster programme's technologies have been prioritised as strategic focus areas for development in the plans of the regional Centres of Expertise and development companies, regional councils and universities. In addition, the cluster and its individual sectors are being developed nationally as part of the Tekes Technology Programme. Furthermore, many companies and industrial associations have worked out and published plans in which the cluster's technologies represent a key role for maintaining and improving competitiveness. Nokia, for example, has published its own nanotechnology strategy.

### 2.3 Strategic goals

The cluster programme's goals are divided into qualitative and quantitative goals. The qualitative goals define the main lines of activities and confirm with the goals of the national Centre of Expertise Programme for 2007-2013. The quantitative goals have been set for some of the qualitative goals to help monitor and assess the success of the cluster programme.

#### Qualitative goals

The qualitative goals are as follows:

- To strengthen expertise and new forms of co-operation
- To increase business and employment based on top expertise
- To strengthen internationality and attractiveness.

These qualitative goals direct activities, but they are insufficient in themselves to monitor and measure the success of the activities. The realisation of the goals is monitored through impact indicators that make the planning and monitoring of activities concrete. The impact indicators also help detect any need for change and plan the necessary actions during the course of the programme.

## Quantitative goals

The quantitative goals are connected with the impact indicators. In terms of realising and monitoring the goals, the national level is the most important. For the sake of transparency and regional development, quantitative goals have also been set for each Centres of Expertise. The quantitative goals for 2010 and 2013 are presented in Table 2. These may be amended during the course of the programme.

Table 2: Quantitative goals of the cluster programme on the national level.

Impact indicators	2010	2013
Strengthening new forms of co-operation		
• Share of funding for joint projects in the cluster, %	40	70
• Number of SMEs participating in the programme	124	221
• Total number of companies participating in the programme	172	272
• Share of competed funding, %	30	50
Increasing business and employment of participating companies based on top expertise		
• Number of new companies	23	51
• Turnover of companies greater than average, %	10	10
• Exports of companies greater than average, %	10	10
• Number of new jobs in companies	1110	1930
Strengthening internationality and attractiveness		
• Number of international companies or research units started up in Finland	10	20

Considerable uncertainties are involved in setting and also monitoring quantitative goals. This is partly due to the fact that the cluster is not an industrial sector and consequently its impact indicators are not monitored by official statistics. In addition, the key figures of the companies counted within the cluster, such as turnover, exports and jobs, include many products that do not belong to the cluster.

### 3. STRATEGIC ACTIONS

The actions required to realise the goals of the cluster programme are divided into two groups of strategic actions. These are:

- Networking and co-operation (regionally, nationally, internationally)
- Key projects and their extension projects.

These two strategic action groups are interlinked and mutually supporting.

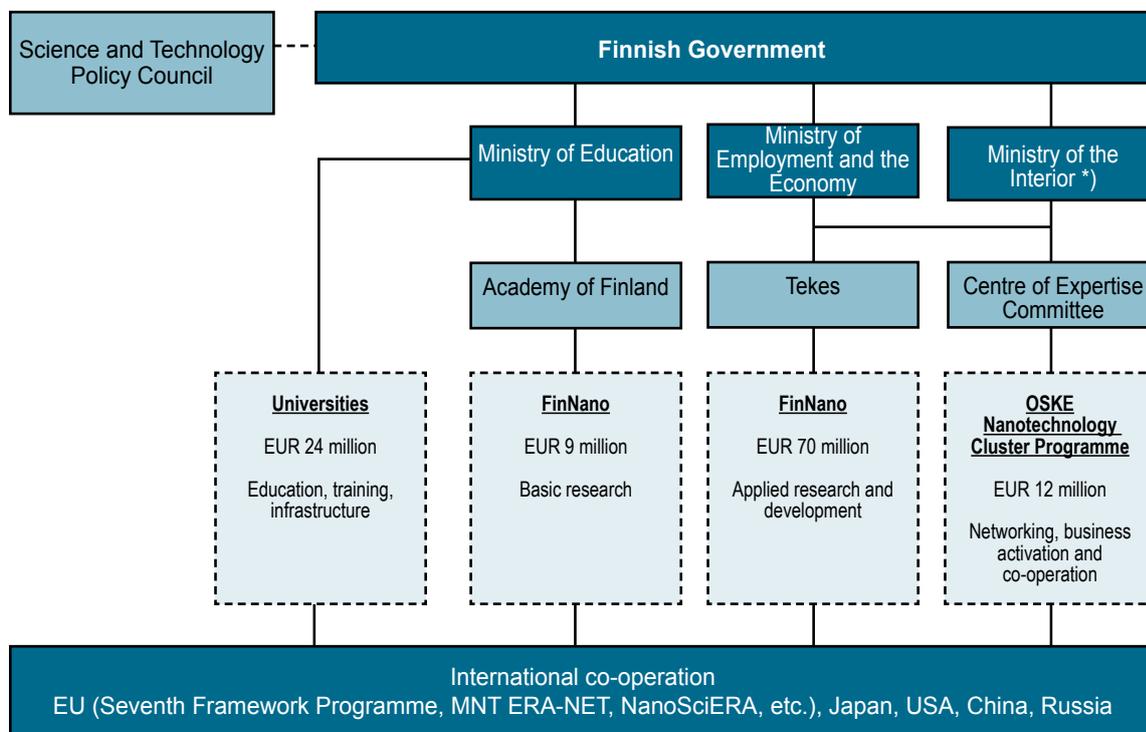
These strategic actions create added value that will be needed in order to achieve a significant change from regionally centred activities to national co-operation. Another key change will be the increase in international activities, both from Finland outwards and to Finland inwards.

#### 3.1 Networking and co-operation

Strengthening networking and its related co-operation is one of the main focus areas of the programme. The aim is to achieve a common view about the vision, concrete goals, concrete methods and projects, funding and its acquisition, and the organisation of co-operation. This shared view will lead to concrete joint projects and the commitment of the parties to common goals. The emphasis of networking initially is on the national level. The success of this will support also international networking and co-operation.

#### The cluster programme as part of the national innovation policy

The cluster programme is part of the national innovation system and implements the national innovation policy. Key co-operation partners include Tekes (Finnish Funding Agency for Technology and Innovation) and its technology programmes, especially FinNano 2005-2010 and Functional Materials 2007-2013, Tekes’s business development programmes, the Academy of Finland’s FinNano programme 2006-2010, and the Ministry of Education’s nanotechnology programme 2007-2009 (Fig. 4). Other important co-operation partners include the new strategic centres for science, technology and innovation, the Academy of Finland’s relevant top research units, and the national associations of the main industrial sectors, particularly the Federation of Finnish Technology Industries.



Source: Tekes

Fig. 4: The Nanotechnology Cluster Programme as part of national programmes.

\*) only during 2007

Tekes offers important contacts to the relevant technology programmes and their programme directors and co-ordinators. In addition to the technology programmes it is important to monitor Tekes's activities on the whole, including strategy updates and the development of new services and forms of funding. Other national innovation and technology policy actors include: science parks, business incubators and the Finnish Science Park Association TEKEL; corporate funding agencies, such as Finnvera and Employment and Economic Development Centres; venture capitalists, such as private fund management companies and government-owned investment companies, such as Veraventures and Finnish Industry Investment Ltd. Other important co-operation partners include research institutes, like the Research Institute of the Finnish Economy ETLA, the Ministry of Education, Invest in Finland, and Finland's international Innovation Centres (e.g. in Palo Alto, USA; in Shanghai, China; in St. Petersburg, Russia).

Although statistics are available to monitor the sector development of the companies participating in the cluster programme, foresight activities are also required. Changes in the operating environment will be assessed annually by utilising for instance the Science and Technology Policy Council, Tekes, the Academy of Finland, the Federation of Finnish Technology Industries, ETLA and the Finnish Association of Graduate Engineers TEK. International experts may also be used in compiling these annual assessments.

The roles played by the cluster programme and the new strategic centres for science, technology and innovation are illustrated in Fig. 5. In sectors covered by the strategic centres, the cluster programme focuses on the more advanced stages of business development than the strategic centres. The cluster programme also operates in sectors not covered by strategic centres, in which cases the focus of the projects can be on earlier stages of business development. In addition, the cluster programme has a comprehensive operative co-operation network, making the implementation of national plans and decisions effective throughout Finland.

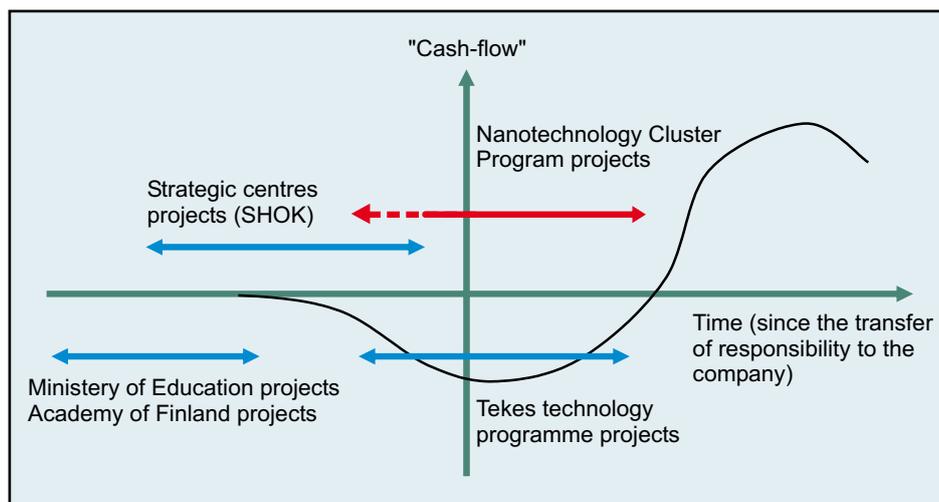


Fig. 5: The roles played in the life cycle of new products or businesses by the Nanotechnology Cluster Programme, the strategic centres of science, technology and innovation and other national projects belonging to other programmes.

**The cluster programme and activating international operations**

Activities are focused on helping companies establish international contacts with companies and research organisations in potentially important markets. Establishing international contacts is particularly important for SMEs. Even bigger companies may not be aware of all opportunities, especially if these companies are not yet active in the markets in question. Joint projects between research organisations and foreign groups are also activated and supported. A business partner is always sought for these projects.

The cluster programme participates in meetings with key actors in the technology and innovation policies of different countries together with such organisations as the Ministry of Trade and Industry (Ministry of Employment and the Economy) and Tekes or by organising such meetings itself. Key markets include Russia, China, Japan and the USA, and later also India, Australia and South America.

The cluster programme also arranges high-level professional visits (companies, research units) to and from Finland, as well as joint participation in trade fairs and conferences. International experts (companies, research units) are invited to seminars that are organised in Finland. The cluster programme is promoted and presented at international trade fairs and conferences.

The aim of these activities is to create internationally funded joint projects, for example within the EU's Seventh Framework Programme. The aim is also to arrange co-operation with actors representing new markets and to create co-operation and business that is considered important by the companies themselves. Achieving these aims is facilitated by the increasing awareness of Finnish expertise worldwide. This is supported and profiled by adopting a common brand, "Nanotech Finland", together with other nanotechnology programmes in Finland.

### 3.2 Key projects

Concrete R&D projects are necessary for achieving the cluster programme's goals. The most important of these are the so-called key projects, some of which are joint – "national" – and others "regional". These key projects promote co-operation between the different centres and their areas of expertise and strengthen national expertise. The key projects often utilise the results of Tekes's FinNano programme or other Tekes programmes and the Academy of Finland's FinNano programme. Through these key projects, significant change is sought in specific areas, including: understanding how technologies can be exploited; the ability of companies to exploit technologies; the conditions required for commercial applications; development of innovations and business. The aim is to create extension projects, for example product development projects, especially those funded primarily by companies themselves, as a result of these key projects. National and international venture capitalists may also be needed to fund these projects. Broader projects that can receive funding from Tekes's FinNano programme, other Tekes programmes or EU programmes, including within the Seventh Framework Programme, are also sought through these key projects.

Nevertheless, actual changes in business will be realised only as a result of development projects within the companies following the key projects. These changes include: new products; increased turnover; and increased exports and resulting jobs, which may be new jobs or retained jobs. The actual added value of the cluster programme will be measured according to the achievement of these partly indirect goals.

The key projects will be implemented according to the following themes:

- Applications in technology and forest industries
- Applications in chemical, plastics and construction industries
- Applications in energy and environmental technology
- The development of generic technologies and their applications
- Business activation, pilot factories and technology transfers especially to SMEs
- Increasing the global business activities of companies
- Characterisation and safety.

These key project themes are divided into three groups, all of which are different yet equal in importance. The applications are important for global markets in terms of developing products, regardless of company size. Activation and supporting the development of global business are particularly important for SMEs. Characterisation and safety constitute an essential element, especially in terms of the social acceptance and adoption of nanotechnology.

## 4. ORGANISATION OF THE CLUSTER PROGRAMME

The organisation of the Nanotechnology Cluster Programme involves national co-ordination on the one hand and activities of regional Centres of Expertise on the other. Each of these organisational levels has its own implementation organisation and co-operation bodies.

### 4.1 Co-ordination of the cluster programme

The realisation of the changes and added value sought through the cluster programme are supported by the duty of a national co-ordinator (Programme Director).

The responsibilities of the co-ordinator are described as follows:

- To co-ordinate and direct operatively the implementation of the joint activities and projects of the cluster's Centres of Expertise
- To ensure the progress and reporting of the cluster programme's implementation together with other participating Centres of Expertise
- To establish and maintain contacts with national and international actors and programmes that are important for the implementation of the programme, especially with Tekes's technology programmes, the Academy of Finland's top units, the new strategic centres being formed, and the EU's framework programme for research
- To establish contacts with other clusters and the national committee for the Centre of Expertise Programme and its related projects
- To establish contacts with international actors and networks
- To produce together with expert partners an annual foresight report for the cluster
- To report to the cluster's executive committee about any changes in the centre of expertise environment
- To participate in the planning of national communications
- To initiate joint training and development projects among the cluster's Centres of Expertise
- To ensure that the cluster's activities are closely connected with the national innovation and technology policy.

Jyväskylä Innovation Ltd is responsible for the national co-ordination of the cluster programme for the period 2007-2010 and Culminatum Ltd for the period 2011-2013. The co-ordinator has a part-time assistant for the entire duration of the programme. Funding for the co-ordination of the programme is provided by the Ministry of Employment and the Economy (earlier Ministry of Trade and Industry) and the cluster programme's regional Centres of Expertise together.

The executive committee of the cluster is responsible for the operative planning and implementation of the cluster programme. The members of the executive committee include representatives of the Centres of Expertise participating in the cluster programme plus the co-ordinator. Since the executive committee decides about the national key projects, its members must have the authority within their regions to channel the basic national funding of their Centres of Expertise to these joint projects within the framework of the specified budget. The executive committee approves an annual operating plan and its related goals of impact indicators.

The cluster programme also has a steering committee that consists of representatives of companies, funding bodies, universities and research institutes and centres of expertise who are knowledgeable about nanotechnology. The steering committee serves as a "national cluster forum" that complements other forums operating by region or area of expertise. The tasks of the steering group include the strategy of the cluster programme, as well as promoting networking and co-operation.

The national organisational bodies of the cluster programme are presented in Fig. 6.



Fig. 6: The national organisational bodies of the cluster programme.

## 4.2 Activities of the Centres of Expertise

The responsibility of each Centre of Expertise implementing the cluster programme is specifically appointed to an organisation that is authorised by its region. Each Centre of Expertise participates in and is responsible for the planning and implementation of the cluster's internal division of duties and its own area of expertise according to its specialisation. In addition, all centres of expertise participate in the planning and implementation of national key projects within the cluster. In each responsible organisation or implementation organisation appointed by it works a person responsible for the regional Centre of Expertise. In practise the responsible organisation is a science park or innovation company (Ltd).

Each Centre of Expertise is typically supported by a regional group of experts that may act more broadly as a regional forum or mini-cluster within its area of expertise. In addition, the Centres of Expertise have regional steering groups that plan and monitor their operations. These steering groups typically include regional funding agencies and other stakeholders.

## 5. CENTRES OF EXPERTISE AND THEIR TOP EXPERTISE

### 5.1 Helsinki Region Centre of Expertise

The Helsinki Region Centre of Nano Expertise is part of the Helsinki Region Centre of Expertise and the national Nanotechnology Cluster Programme. Helsinki Region's core areas of expertise in the cluster programme are nano- and microsystems and international clusters.

The Helsinki Region is home to an extremely significant nano- and microtechnology and new materials expertise. In addition to related research, the region has nationally and internationally significant industrial production and organisations supporting innovation activities in these areas, as well as top expertise in other scientific areas. The geographic proximity of such a large group of actors combined with top expertise creates exceptionally good conditions on the national level for groundbreaking innovation activities.

The Helsinki Region Centre of Expertise faces a challenging task to support and facilitate the co-operation of this massive group of actors. Fortunately, important steps have already been taken in this direction. The Finnish Micro Nano Technology Network (FMNT), which was named Project of the Year in 2002, continues to be co-ordinated by the Helsinki Region Centre of Expertise. In addition to the Helsinki Region Centre of Expertise, the region is home to other actors that have helped strengthen co-operation in this field and created effective co-operation forums. These include VTT's and Helsinki University of Technology's Micronova with its 2600 m<sup>2</sup> of clean rooms and state-of-the-art R&D equipment, Helsinki University of Technology's Centre for New Materials with its 22 laboratories, and Spinverse Consulting, which is co-ordinating Tekes's FinNano programme. The Helsinki Region Centre of Expertise will continue to work in close co-operation with these organisations.

The Helsinki Region Centre of Expertise's programme was prepared in 2006 in co-operation with the executive committee of the Centre of Expertise for Active Materials and Microsystems. The executive board consisted of representatives of Adaptamat, Detection Technology, EVTEK Electria, Nokia Mobile Phones, Technomedicum, Technopolis Ventures, Helsinki University of Technology, Helsinki Region Regional Council, the TE Centre for Helsinki Region, VTI Technologies and VTT. The programme will be further refined and focused in close co-operation with a new steering group consisting of representatives of the Helsinki Region Region's most important actors in the field of nano-, micro- and new materials. Members of this steering group are representatives of related companies, Helsinki University of Technology, the University of Helsinki, VTT and the Helsinki Region Regional Council.

In addition to this steering committee, the Helsinki Region Centre of Expertise works in co-operation with other co-operation partners including Technopolis Ventures, MIKES, RFID Lab Finland, EWTEK Electria, FINALD, the Helsinki-Nano community, Tekes, Haaga-Helia, the Helsinki School of Economics' Small Business Centre, the Chemical Workers' Union, the Finnish Meteorological Institute, Laurea, other Helsinki Region centres of expertise, other clusters and funding agencies.

#### Leading expertise, networking and utilisation

##### Research and education

Helsinki Region is home to an extremely significant nano- and microtechnology and new materials expertise that accounts for up to 60 percent of Finland's resources. The core of this group consists of the 22 laboratories of Helsinki University of Technology's Centre for New Materials, the Kumpula, Viikki and Meilahti units of the University of Helsinki, VTT's expertise clusters, MIKES, KCL and the Finnish Centre for Science CSC. Applied R&D is also carried out at the EVTEK and Stadia polytechnics. The Helsinki-Nano project includes a total of 30 laboratories and 200 researchers from Helsinki University of Technology, the University of Helsinki and VTT, and another 200 researchers are active in other microtechnologies. The total number of R&D personnel in micro- and nanotechnology companies is approximately 500.

### Business activities

Helsinki Region is home to around half of Finland's MNT companies, over 60 percent of the value of production and approximately 35 percent of the sector's labour force. There are around 70 micro- and nanotechnology companies, of which two-thirds are starting up or developing. The total number of jobs is approximately 3000, and the combined turnover of companies is approximately EUR 450-500 million (not including Nokia and GE).

Technology companies based in the Helsinki Region and active in international markets include Vaisala, VTI, Okmetic, Suunto, Orion Diagnostica, Thermo Electron, Planar Systems, Detection Technologies, ST Microelectronics, Oxford Instruments and Kemira Pigments. SMEs include MAS, Liekki, Silecs, Partnertech, SIP, Photonium, Pikoteknik, Heptagon, IST, Picosun, Singulase, Beneq, Intune Circuit, Fluilogic and Adaptamat.

In addition to the above, major corporations like Nokia and GE Health Care utilise the expertise of this cluster.

### Networking

The Helsinki Region Centre of Expertise is active in the following Finnish networks:

- The most obvious cluster co-operation is carried out within the national Centre of Expertise forum represented by the Nanotechnology Cluster Programme. The cluster's advantages include a) the opportunity to compare and spontaneously analyse the best practices of the cluster tools within the programme, and b) the opportunity to present the projects of the centres of expertise in a common forum and to obtain feedback, comment and identify the best actors in Finland.
- The FinnishMicroNanoTechnology (FMNT) network co-ordinated by the centre of expertise is a ready cluster tool that nevertheless requires development. In recent years FMNT has focused on trade fair participation, which will continue albeit in a more focused manner. The FMNT website will be updated with the intention of utilising it as an event calendar and to provide information.
- The Fine Particle Forum exists but requires a lot of active work to profile itself on the national level as an important actor. The website is being launched in connection with the annual autumn seminar 2007 and the kick-off of a new mini-cluster for industrial applications. Plans are to develop the Fine Particle Forum into an international actor.
- The "NanoPump" is the Helsinki Region Centre of Expertise's first keyproject and brings together actors in a kind of minicluster. The project will clarify whether there is cause to structure co-operation more clearly.
- The NanoHarju project concluded in 2006. The project brought together nanotechnology actors from Lohja in a common forum, and effective contacts were established with the TianJin Nanotechnology Cluster in China. Utilising the work carried out in this project will be clarified within the framework of the centre of expertise programme at the start of the period.
- The Helsinki Region NanoForum was gathered in early autumn 2007. The forum brought together the most important actors in the field in Helsinki Region to serve as a steering group for the centre of expertise, as well to provide an open forum for creating ideas.
- A mini-cluster for surfaces and surface materials utilising nanotechnology was planned during autumn 2007. A kick-off seminar will be held for the mini-cluster.

The goals of the Helsinki Region Centre of Expertise are:

- To expand, improve and facilitate co-operation between actors in Helsinki Region
- To identify essential development needs within Helsinki Region and to introduce projects to fulfil these needs
- To support the creation of new business in the field
- To strengthen the international image of Helsinki Region and the rest of Finland as an extremely strong and attractive R&D environment, co-operation partner, business and investment location for nano- and microtechnologies and new materials
- To maintain and expand co-operation with international clusters and especially European actors in the field.

## 5.2 Jyväskylä Region Centre of Expertise

The Nanotechnology Centre of Expertise is part of the Jyväskylä Region Centre of Expertise and the national Nanotechnology Cluster Programme. Jyväskylä's core areas of expertise in the cluster programme are nanotechnology, especially functional and self-assembling nanostructures.

The programme has been prepared together with a cluster-based development programme for Central Finland. The following companies have participated in preparing the programme: Amroy Europe, Ecocat, Metso Paper, M-real, Nokia, Metsä-Botnia, Pöyry, Ramboll Finland, SunCom Systems, Tieto-X, UPM and Vapo, as well as the following publicly funded actors: the University of Jyväskylä, Jyväskylä University of Applied Sciences, Jyväskylä Educational Consortium, the City of Jyväskylä, the Rural Municipality of Jyväskylä, Jyväskylä Regional Development Company Jykes, Technopolis, Jämsek, the Regional Council of Central Finland, TE Centre for Central Finland, TE Centre for Central Finland /Technology Development Department/Tekes, Keulink, Saarijärven Yrittäjäpalvelu, Witas, VTT and Ääneseudun Kehitys. Each of the above has participated in preparing the programme as a representative of its own interests or interest groups in such a way that the programme serves all the intended beneficiaries.

### Top expertise, networking and utilisation

The participation of Finland's first genuine nanoscience and nanotechnology centre and the strong presence of forest cluster applications are highlighted in the roles played by the Jyväskylä Region Centre of Expertise within the expertise cluster. The third key role is to serve as the cluster's active partner in the Jyväskylä Region and more broadly in Central Finland.

The University of Jyväskylä's Nanoscience Center (NSC) is part of the Centre of Expertise and offers an example of nanotechnology research in which difference sciences (physics, chemistry, biology) work together concretely under the same roof. Other centres of expertise can utilise the NSC's pioneering experience and expertise, for example through the cluster's joint projects or through bilateral projects.

The most important sector within the Centre of Expertise's region at the start of the programme period is the forest cluster and the related papermaking and mechanical engineering industry. The region is home to global technology and market leaders and their production plants. The forest cluster is regenerating and intends to utilise the expertise of the Nanotechnology Cluster Programme for this purpose. During the course of the programme applications are expected to be created for the metal industry, the ubiquitous computing and wellness clusters, the energy and environment cluster, the electronics industry and the construction industry.

The Nanoscience Center's areas of expertise include:

- Nanoelectronics, molecular electronics
- Nanophysics, carbon nanotubes
- Thermal properties of nanostructures
- Theoretical nanophysics
- Computational nanophysics
- Supramolecular chemistry
- Nanoparticles
- Ultracold chemistry
- Femtochemistry
- Biochemistry, biosensors and viruses
- Molecular biology
- Cell biology
- Biotechnology

According to Central Finland's technology strategy, the region is home to seven major corporate R&D centres or network nodes. In addition to these, numerous SMEs carry out their own R&D work. The R&D operations of these companies is focused on developing products that are already on the market or very close to entering the market. This work is characterised for companies of all sizes by co-operation between customers and universities and research institutes.

## Goals

The vision for 2013 is that Jyväskylä is recognised globally as an important Finnish developer and applier of nanoscience and nanotechnology that serves companies in different sectors and that creates new growth companies. To fulfil this vision the goals are to:

- Create new forms of co-operation
- Increase business and employment based on leading expertise
- Strengthen internationality and attractiveness, which also requires strengthening expertise.

More specifically, the aim is to help support regional specialisation and the division of duties internationally to create competitive centres of expertise. The Jyväskylä Region Centre of Expertise has two key methods in this regard. The first is to offer its special expertise for use by other regions. The second is to develop the NSC and its associated research units into a globally attractive nanotechnology innovation environment that other centres of expertise can use as a model. This would help it attract internationally active companies, investments and leading experts to the region.

The goals of the centre of expertise also include creating new innovations, products, services, companies and jobs based on top expertise. Alongside new companies utilising nanotechnology as a core expertise, it is important that the technology is transferred to existing companies, including SMEs capable of growth and big companies that already have global operations and are thus able to exploit faster the new business opportunities.

## 5.3 Kokkola Region Centre of Expertise

The Kokkola Region Centre of Expertise is participating in the Nanotechnology Cluster Programme by applying nanotechnology within the chemical industry, especially with regard to the development of metal chemicals and polymer and composite materials.

The programme and its content have been prepared in workshops and committees in which the region's companies, education and research organisations, economic companies and councils have been represented. The regional councils of Kokkola, Pietarsaari and Kaustinen have pledged to fund the implementation of the centre of expertise programme. The Federation of Education in Central Ostrobothnia, the Chydenius Institute – Kokkola University Consortium and the Central Ostrobothnia University of Applied Sciences have pledged to implement the programme in their own strategies. The centre of expertise programme for chemistry is one of the focus areas in the implementation plan of the Central Ostrobothnia regional development programme.

### Top expertise, networking and utilisation

Developing nanotechnology in Kokkola refers to the development of expertise in the synthesis and processes of nanoparticles, the changes caused by nanotechnology within traditional production processes, developing analysis and nanotechnology applications in commercial products, for example in the development of polymer and composite materials.

Key actors in R&D activities involving chemistry include: the Chydenius Institute – Kokkola University Consortium, the Central Ostrobothnia University of Applied Sciences/CENTRIA Research and Development, Technology Centre KETEK, METLA Kannus Research Unit, Geological Survey of Finland GTK, and companies. Analysis services in the region are also offered by the Kokkola and Pietarsaari food and environmental laboratories, as well as Nablabs Oy. Altogether over 250 people work in research, R&D and analysis services in the region.

Kokkola has laboratory and pilot-scale equipment that offers a development, testing and process scale-up environment for R&D and commercial projects involving nanotechnology applications.

The University of Jyväskylä, University of Oulu, University of Vaasa and Tampere University of Technology are active in the Chydenius Institute – Kokkola University Consortium. The Professorship of Applied Chemistry under the University of Oulu focuses on material chemistry and industrial applications of chemistry. The Applied Chemistry Research Group carries out research in such areas as heterogenic catalysts and nanocatalysts. The group's research areas include manufacturing

techniques for nanoparticles, separation processes, customising surface properties, and the effects of operating environments on the structural and functional properties of materials. Key research areas in analysis include the characterisation of surfaces on the micro and nano scale. Tampere University of Technology's Laboratory of Plastics and Elastomer Technology research group focuses on polymers and composite materials. The Chydenius Institute – Kokkola University Consortium also introduced in spring 2007 an adult education programme aimed at a master's degree in Chemistry and Technology in co-operation with the University of Oulu and the Central Ostrobothnia University of Applied Sciences.

As the Centre of Excellence in Regional Impact, the Central Ostrobothnia University of Applied Sciences is Finland's third most international polytechnic as measured by the Ministry of Education. A high-quality international co-operation network covering 120 universities and polytechnics offers a wide range of opportunities for student exchanges and international work practice. The Central Ostrobothnia University of Applied Sciences offers a degree programme in Chemistry and Technology. A higher university degree is also offered through the technology expertise programme.

A pilot-scale chemistry test plant, ChemPlant, is currently being built by the Central Ostrobothnia University of Applied Sciences's CENTRIA Research and Development unit in Kokkola. ChemPlant's processes can be utilised as a direct continuation of previous processes or as separate processes. The plant will feature comprehensive data acquisition equipment, and the instrumentation will comply with the ATEX directive for explosives. The CENTRIA Research and Development unit in Ylivieska offers wood product and production technology services. The surface treatment department in Ylivieska has industrial-standard surface treatment equipment.

The Technology Centre KETEK focuses on applied chemistry research and product R&D, process development and the analysis of metal chemicals, polymers and composites, and fine chemicals based on the needs of industry. Laser technology expertise (surfacing, welding and cutting) in metal and workshop applications are utilised in applying these techniques to plastics and composite materials. Analytics focuses on consistency definitions, thermal analysis and environment and corrosion testing. KETEK possesses leading expertise in measuring small concentrations. The centre's laboratory facilities cover 1000 m<sup>2</sup> and include a clean room.

As a result of new European Community regulations on chemicals and their safe use (REACH), environmental and health and safety issues are increasingly important in terms of business operations and new chemical innovations. KETEK offers REACH implementation services for companies as part of a national pilot project and focuses on developing its expertise in this area.

The Central Ostrobothnia Adult Education Institute is Finland's leading vocational trading centre for process technology. The institute has pilot-scale equipment for manufacturing pulp and for the electrochemical surfacing of metals and plastics.

Both the Kokkola and Pietarsaari vocational institutes offer chemistry studies with degree programmes for laboratory technology, process management, surface treatment and the boat and plastic sector. The English-language laboratory technology programme at Kokkola prepares students for international positions and includes practice abroad. Pietarsaari offers a Swedish-language laboratory technology programme.

A significant number of university-educated researchers are employed by companies in the region. For example, the OM Group has concentrated its entire R&D operations in Kokkola. KWH Group companies also possess considerable research resources.

## Goals

The goals of the centre of expertise programme are to:

- Modernise industry by developing new, more highly-refined products that create added value
- Improve profitability by developing expertise and utilising new technologies
- Safely use chemicals and production processes and promote the principles of sustainable development
- Create services and new business models especially for industrial spin-offs and innovations into profitable business operations.

## 5.4 Mikkeli Region Centre of Expertise

The Mikkeli Region Centre of Expertise is participating in the Nanotechnology Cluster Programme through two areas of expertise: thin film coatings and plastic composites.

The preparations for the programme have been co-ordinated by the Mikkeli Technology Centre and have included the participation of Mikkeli University of Applied Science, Lappeenranta University of Technology, the Mikkeli units of the University of Kuopio and the Helsinki School of Economics, the City of Mikkeli, the Regional Council of South Savo and the TE Centre for South Savo, as well as leading companies in the region, including Savcor Group, Exel, Ahlstrom Glassfibre and Environics. These actors are also represented in the steering group of the Mikkeli Region Centre of Expertise. The broad participation within the region is strengthened by a committee formed alongside the steering group and including technology experts and researchers. This expert committee focuses on planning the content of activities, project planning, and directing implementation.

### Top expertise, networking and utilisation

Special expertise in functional surfaces is represented by the Advanced Surface Technology Research Laboratory (ASTRaL), a research unit of Lappeenranta University of Technology, and two leading companies applying technologies commercially, Savcor and Environics, as well as other research units networking with these. The Material Technology Laboratory at Mikkeli University of Applied Science offers high-quality equipment resources for fabrication and characterization of thin films and surfaces. The key coating technologies are atomic layer deposition (ALD) and sputtering.

Another focus area of the Mikkeli Region Centre of Expertise is research, design, simulation and testing of new plastic composite structures. State-of-the-art modelling methods, design expertise and advanced test equipment are utilised. The key actors in this field include the Mikkeli Unit of the Tampere University of Technology's Laboratory of Plastics and Elastomer Technology, the material and wood technologies units of the YTI Research Centre, two leading companies in the region, Exel and Ahlstrom, as well as other companies active in the plastic composites sector. Co-operation is also carried out with the Computational Mechanics Laboratory (CompMechLab) at the St. Petersburg State Polytechnical University for the mathematical modelling of structures. The material technology laboratory at the Mikkeli University of Applied Science offers a wide range of state-of-the-art equipment for research and testing.

The increasing use of new materials, especially nanomaterials, in environmental technology and the applied research related to this will be another focus area of the centre of expertise. Key actors in this area include ASTRaL and the University of Kuopio's Laboratory of Applied Environmental Chemistry in Mikkeli.

Developing the testing, prototype and pilot production environments together with companies will enable and boost commercialisation of new thin film and material solutions.

Developing business expertise is supported by the Helsinki School of Economics' Small Business Centre. The core areas of expertise of the Small Business Centre include development of business models for SMEs, knowledge of industrial sectors, special training programmes for SMEs, consulting individual SMEs as part of the education programme, and international relations. Within the framework of the centre of expertise, this expertise will be applied especially to researching the business environment of technology-based start-up companies and supporting the business planning of these companies.

Supporting the internationalisation of companies forms part of the centre of expertise's activities. The centre of expertise's special strength in this area is its excellent knowledge of Russia and the strong presence of the St. Petersburg economic area in particular through Russian representative offices in Eastern Finland, where the Small Business Centre has been active since 1998. The centre of expertise has access to services provided by technology experts particularly in St. Petersburg, which facilitates direct contacts with Russian universities and research institutes.

The Saimaa Science Park (SSP) project aims to create an internationally competitive operating concept for material and environmental technology R&D in the Mikkeli Region. The project highlights the actions

to be implemented in the course of the new programme period in order to create an internationally recognised and acknowledged expertise cluster.

## Goals

The programme corresponds very well with the regional development plans for South Savo. Material technology was selected as one of the key strategic development areas of the region's Innovation Strategy that was adopted in 2001. Since then it has been included as one of the key development areas in the strategies of the Mikkeli University Consortium, the Mikkeli University of Applied Science and the City of Mikkeli. Developing material and environmental technologies will consequently be one of the key strategic goals of all actors in South Savo during the 2007-2013 programme period.

Vision: In 2013 the Mikkeli Region is one of Europe's most important centres for the development of plastic composite and thin-film technologies that networks and spreads research data globally while stimulating new research projects and business activities.

The goals are as follows:

- The Mikkeli Region Centre of Expertise is an important actor on the national level. It implements annually two new national development projects related to its own area of expertise and plays an active role in the national clusters.
- The centre of expertise has an important international co-operation network within its area of expertise, and it has carried out the first development projects funded by the EU framework programme.
- The centre of expertise supports high-level basic and applied research.
- Education related to material and environmental technology offered by the Mikkeli University of Applied Science and other education providers in Mikkeli has increased significantly.
- The Saimaa Science Park concept has established a position as the engine of material and environmental technology development in South Savo.

## 5.5 North Karelia Centre of Expertise

The centre of expertise for photonics and material and precision technologies forms part of the North Karelia Centre of Expertise and the national Nanotechnology Cluster Programme.

Photonics has been named one of the most important technologies for European competitiveness. "The European Platform Photonics21" strategy commissioned by the European Commission outlines five key areas in which photonics plays a key role in terms of applications and processes:

- Information, imaging and communications technology
- Lighting and display technologies
- Production and fabrication techniques and quality
- Biological sciences and healthcare
- Safety and reliability

In the strategies and forecasts made by Tekes and the Academy of Finland, the role of photonics and material and precision technologies is defined as central in terms of national research and industry. North Karelia has been a pioneer and trendsetter in this branch. Focused efforts over the past decades have made the Joensuu Region Finland's leading and an internationally respected centre of expertise for photonics and material and precision technologies. In addition to the University of Joensuu, North Karelia University of Applied Sciences and the Imtec precision manufacturing centre at the Joensuu Science Park, a number of expert companies operate in the region whose services and expertise are utilised by many leading Finnish and international companies. Joensuu's core area of expertise represents technology that is recognised by many major sectors (plastics and metal, electronics and electrotechnical, ICT and the printing and paper industries) as a way of revolutionising business operations and products.

## Top expertise, networking and utilisation

### Research and education

Leading expertise in photonics research and education is offered in Joensuu by the University of Joensuu's Department of Physics and Mathematics and the InFotonics Center (IFC), which was established in 2003. Long-term research by the University of Joensuu's Department of Physics in the fields of wave-optical technology, industrial optics, optical materials and spectral colour research has made it internationally recognised and Finland's leading optical research unit. The department is part of the European Network of Excellence in Micro-optics (NEMO), and it has established relations with Japan's leading research institutes. The IFC is an international-level research and business service centre that combines photonics and information technology. The centre's core expertise is wave-optical technology and spectral colour research. The centre's aim is to establish an intensive co-operation network with the most recognised laboratories and institutes in the field, and to provide an interface between industry and the University of Joensuu in commercialisation of high technology optical research.

The University of Joensuu's Department of Chemistry long-term scientific research in the field of material and physical chemistry and the Special Materials Research Centre (SMARC) are cornerstones of the region's material research. SMARC has developed international-level material technology expertise in a co-ordinated and long-term fashion while promoting the transfer of expertise for industrial applications. The areas of expertise of the University of Joensuu's Department of Chemistry in the field of material research include polymer and composite materials, catalyst chemistry and micro- and nano-level surface phenomena, plus material modelling. A broad national and international research, education and business network has developed around this leading expertise in material technology.

One of the key aims among the region's actor is to develop fabrication, production and precision techniques. The leading expertise related to this is offered by the University of Joensuu's Departments of Physics and Chemistry, IFC, SMARC, North Karelia University of Applied Sciences and Imtec. Research and product development activities at North Karelia University of Applied Sciences focus on the design and injection moulding of small components measured in millimetres. In addition, research is carried out in the fields of micro-optics (modern optics) and microfluidistics (lap-on-chip). The materials used for small components include plastics and ceramic and metal particles mixed with plastics (CIM and MIM). The focus of research into micro-optical components is on production methods, such as injection moulding techniques, and optical products requiring moulding techniques. Technologies being researched include ICM (Injection compression moulding), nano machining (laser ablation and diamond machining) in the production of moulding parts, and heat conduction in the injection moulding of microstructures. An assessment council of polytechnics named North Karelia University of Applied Sciences one of Finland's top four polytechnics in 2004. North Karelia University of Applied Sciences has played a strong role in increasing the level of expertise, developing an innovation environment and creating networks between key actors in the region. Imtec's core areas of expertise are micromechanics and special machining technologies, plus tooling techniques. These methods allow structures of only a few millimetres to be fabricated and, in the future, surface qualities of only a few nanometres to be achieved for optical applications, for example.

### Business activities

In addition to the region's research and education organisations, many companies in the region support the photonics and material and precision technologies centre of expertise through their own expertise or participate actively in developing technologies in order to utilise these benefits in their products or production. In addition to developing technologies, these actors strive together to commercialise new research results and applications created by photonics research. The region's research network and companies have together created the Optics River added-value chain for wave-optics and precision manufacturing. In the added-value chain, each actor brings its own special expertise to a broader service concept, allowing the chain as a whole to offer customers customised services ranging from research to the mass production of optical and precision products. Optics River's activities have resulted in a broad international business and research network and the creation of new companies. In Finland and internationally, the utilisers of photonics and material and precision technologies can be found in a wide range of industrial sectors, including the Nokia-led ICT sector, the plastics and metal

industry and the paper and printing industry. Business co-operation has created applications in the fields of display and lighting technologies, light sources, new imaging techniques and production and fabrication techniques. The Nanotechnology Cluster Programme will allow the expertise and services offered by the photonics and material and precision technologies centre of expertise to become better recognised nationally and internationally.

### Goals

Vision: Joensuu is one of Europe's leading centres of expertise for photonics and material and precision technologies in 2013.

In the 2005 development programme for Eastern Finland, photonics is listed as one of the key areas of expertise for Eastern Finland, whose integration with strong industrial clusters through cross-regional macroprojects should be supported. In the recently published North Karelia Development Plan (POKAT 2010) and the Joensuu Region's Business Strategy 2007-2010, photonics and material and precision technologies expertise plays a central role. The region believes in the opportunities offered by new technology and is ready to continue investing even more in its development and commercialisation. Supporting new innovation environments and new and growth-oriented companies is the number one goal according to TE Centre strategies. In a comparison of Finnish R&D operations, Joensuu was ranked in tenth position. A total of EUR 57 million was invested in R&D operations, of which the university was responsible for almost half. In the University of Joensuu's strategy for 2003-2009, optics, new materials and information technology is defined as one of the key focus areas. Education and research in the fields of physics, chemistry and computer science are highlighted in this area of expertise. The regional multidisciplinary university, polytechnic and strong plastics and metal expertise are helping to enable and support the broad utilisation of this centre of expertise. A cross-scientific approach often creates the best innovations. A good example of close regional co-operation is the key project agreement between the University of Joensuu, North Karelia University of Applied Sciences and the Joensuu Science Park. This agreement defines the key activities and goals in research, development and commercialisation activities, as well as the roles of the parties to the agreement and their co-operation. The agreement's topics and themes are strongly based on the activities of the North Karelia Centre of Expertise. The agreement is valid for the entire programme period 2007-2013.

- The turnover of the sector will increase five-fold by 2010.
- The development of business expertise is connected with the development of technology by companies.
- New spin-off and start-up companies are continuously created in the region.
- The business operations of existing companies are international and growing.
- The transfer of leading expertise to companies is direct and effective (process merchandised)
  - Enabling technology->Renewing industry and improving competitiveness
- Co-operation between companies and research institutes is active.
  - Utilisation of Tekes financial instruments and EU framework programme
- Centre of expertise is internationally attractive.

## 5.6 Oulu Region Centre of Expertise

The Oulu Region's core area of expertise within the Nanotechnology Cluster Programme involves multitechnical integrated micro- and nanotechnology products.

The Oulu Region's strong research activities have already created significant international business operations. Around 850 high-technology companies operate in the Oulu Region employing 18,400 people (Oulu Growth Agreement, Annual Review 2005). In addition, the Northern Finland region includes the Ii, Kajaani, Kemi-Tornio and Ylivieska clusters that are home to other high-technology companies and research activities.

In line with Oulu's innovation strategy, the Oulu Region Centre of Expertise is participating in the operation of the five clusters described in Fig. 7: Ubiquitous ICT, HealthBio, Wellness, Environmental

Technology and Nano. By participating in the Nanotechnology Cluster Programme, the goal is to effectively utilise national expertise and through vertical integration allow research results to be commercially utilised as fast as possible.

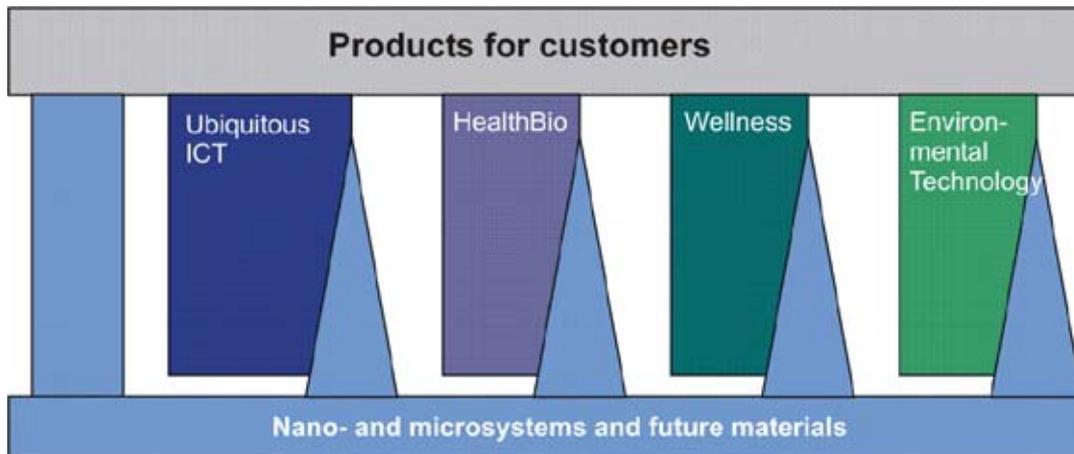


Fig. 7: Oulu's areas of expertise and the role enabled by nano- and microtechnology

The Oulu Region Centre of Expertise includes the University of Oulu, Oulu University of Applied Sciences, VTT, Oulu Innovation, Micropolis (co-ordinator) and regional companies. Oulu brings to the cluster expertise in the multitechnical production and integration of micro- and nanostructures.

### Top expertise, networking and utilisation

#### Research and education

The focus of photonics and micro- and nanotechnology R&D operations at the University of Oulu and VTT in Oulu is on integrating nanoscale photonics, electronics (organic FET and OLED components) and biomedical components and biosensors, and intelligent materials into a functional entity. Over 100 people at the University of Oulu (Microelectronics and Material Physics Laboratory, Optoelectronics and Measurement Technology Laboratory and Electronics Laboratory within the Department of Electrical and Information Technology, plus the Chemistry Department) and 100 people at VTT in Oulu are active in research in this field.

The Oulu Region Centre of Expertise's core areas of expertise are related to the production and integration of micro- and nanostructures and the testing of nanoelectronics.

- Roll-to-roll manufacturing, electronics/optics/bio and the above-mentioned combinations
- Biosensors
- Organic electronics components
- Production and integration of micro- and nanoscale structures into functional systems
- Electroceramics (RF ceramics, MIT-, piezo- and ferroelectric ceramics)
- Design and production of nanoelectronics.

The centre of expertise is participating in the following research project funded by Tekes and industry: "Development of novel fabrication methods for nanoscale photonics and microelectronics components" (NAPERO), "Development of production technologies for printable electronics and optics" (R2R2011), "Nanoparticles and polymer composites" (CoNaPo) and "Development of printable electronic coding and RFID technology" (PrinTAG). Other projects include the EU-funded "Development of integrated self-adjusting nanoelectronics sensors" (SANES) and many other international R&D projects (MIND, Patent-DfMM, NEMO, TEMPO OLLA).

The EU's Seventh Framework Programme is considered an important source of funding. VTT is seeking EUR 10 million in 2007 together with Fraunhofer, IMEC, TNO, LETI, CSEM and ACREO. The University of Oulu is seeking EUR 3 million in co-operation with Massachusetts Institute of Technology (USA), the University of Tokyo, Institute of Industrial Science (Japan), AIST (Japan), Rensselaer Polytechnic Institute, University of Missouri-St. Louis (USA), Arizona State University (USA) and EPFL (Switzerland).

The internationality and quality of education of research activities are supported by the fact that Professor Ghassan Jabbour, Arizona State University (USA), was accepted to the Academy of Finland's Distinguished Professor Programme. Professor Ghassan Jabbour is one of the most visible and widely quoted researchers in the field and began working in Oulu in spring 2007.

The international Bio Meets Nano and IT event is held every other year in Oulu, and the Oulu Centre of Expertise participates in its organisation.

### Business activities

The business activities of the electronics industry within the cluster programme's areas of expertise in Northern Finland are strongly concentrated in and around Oulu. Among companies with annual turnover of over a billion euros, Nokia has significant operations in Oulu. Among companies with annual turnover of over a hundred million euros, Aspocomp, Elektrobit and Polarelectro are strong actors within their business sectors, and all have experienced rapid growth in recent years. All of the aforementioned companies rely on a global strategy in which the world's leading experts are sought as partners, and being local does not represent sufficient grounds for co-operation.

Among companies with annual turnover of between 0.2 and 100 million euros, internationality plays a major role in terms of ownership (SwecoPic, National Semiconductor Finland), operations (Detection Technology, half of the employees of which work in China and Hong Kong) and/or customers (Esju, Exens, Inspex, Mediracer, Mikcell, Noptel, Oulun Hienomekaniikka, Rikola, Selmic, Specim, etc.).

New business activities have also been created through business incubators, as demonstrated by such start-up companies as Ball-IT, Braggone, Intopii, Laser Probe, Sensinode and Upstream.

### **Goals**

Oulu's innovation strategy for 2007-2013 is based on the vision that in 2013 Oulu is recognised for its growth companies that are active in global markets. To realise this vision, the activities of the centre of expertise were defined in the strategy according to nano- and microsystems and future materials supporting all four other areas of expertise as described in Fig. 7.

By participating in the Nanotechnology Cluster Programme, the goal of the Oulu Region is to effectively utilise national expertise and through vertical integration allow research results to be commercially utilised as fast as possible.

In particular, the expansion of business activities based on optical measuring technology and the creation of business operations based on printable electronics and optics is expected to create jobs based on leading technology. Currently many product companies (module, product, system) and SMEs offering design/production (electronics, embedded systems and precision mechanics) have set double or triple growth targets for the next six years. Delays by manufacturing and contract design companies in progressing from the ICT sector to other business activities represents a risk.

## **5.7 Tampere Region Centre of Expertise**

Within the Nanotechnology Cluster Programme the Tampere Region Centre of Expertise is divided into photonics (including nanophotonics, optoelectronics and laser technology) and advanced composite materials. Both areas of expertise play a central role in the cluster programme. Various units of Tampere University of Technology (Optoelectronics Research Centre – ORC, Institute of Materials Science) and the Technology Centre Hermia have been primarily active in defining the content of the programme. The region's key companies, the City of Tampere and the region's other municipalities, including the Council of Tampere Region, have committed themselves to the selected areas of expertise.

The content of the centre of expertise is in line with the region's education goals. Education in this area is continuously developed by Tampere's universities and polytechnics based on the latest research knowledge while taking into consideration the needs of companies today. National graduate schools

representing top-level research and education, such as Tampere University of Technology, play a major role. The Graduate School of the Processing of Polymers and Polymer-based Multimaterials (POPROK) is a five-year programme co-ordinated by Tampere University of Technology that began in 2007 and offers ten places. The Graduate School of New Materials and Processes is co-ordinated by Helsinki University of Technology and offers eight places for the 2006-2009 term. The Graduate School of Functional Surfaces and Surface Properties is co-ordinated by Tampere University of Technology and offers five places. The Graduate School of Electronics, Telecommunication and Automation (GETA) is co-ordinated by Helsinki University of Technology and offers 25 places for the 2006-2009 term. The Graduate School of Modern Optics and Photonics is co-ordinated by the University of Joensuu and offers 10 post-graduate places and over 50 other student places. The National Graduate School in Nanoscience (NGS-NANO) is co-ordinated by Jyväskylä and Helsinki together and has offered 14 places for the term beginning in 2005. In addition, Tampere University of Technology and ORC are participating in the National Graduate School of Material Physics (NGSMP) that has been co-ordinated by Helsinki University of Technology since 1995.

## **Top expertise, networking and utilisation**

### Research and education

Tampere is home to an important photonics, thin-film technology and future materials expertise cluster, and the goal is to continue strengthening this cluster internationally. This expertise is based on strong material, nanotechnology and laser research at Tampere University of Technology (ORC, Institute of Materials Science, Institute of Biomaterials, Institute of Chemistry and Institute of Physics) and VTT.

Tampere University of Technology and the Optoelectronics Research Centre (ORC) possess leading internationally recognised expertise in optoelectronics and photonics. ORC's focus areas include semiconductor technology, photonics and nanophotonics, and ultrafast optics and fibre lasers. ORC participates in Tekes's FinNano programme and the Ministry of Education's nanotechnology programme. In addition, ORC participates in the EU's framework programmes and European Space Agency (ESA) projects, many of which are closely connected with nanophotonics. In 2007 ORC was involved in over 20 national and international projects. ORC's co-operation partners in these projects included approximately 50 universities and companies. The total value of these projects was EUR 5.3-5.5 million and the number of employees 65. ORC is recognised for the fact that nearly all its research aims an industrial utilisation, and its research results and technologies can be applied directly by companies regionally, nationally and internationally. ORC is a member of the European Photonics21 platform.

The Tampere University of Technology's Institute of Materials Science is also participating in Tekes's FinNano programme. In 2007 the Institute of Materials Science also carried out many research projects closely connected with future materials and nanotechnology. These included the "NASE – Nanomixed Polymer Composites", "FINSOFC – Metallic Materials in Fuel Cells" and SOFCPOWER projects funded by Tekes, as well as the "POISON – Catalytic Materials: Characterisation and Control of the Surface Poisoning" and "Fabrication and Properties of High Density Ceramic Composites" projects funded by the Academy of Finland. In addition to Tampere, many of these material and nanotechnology projects have included other research parties, including the Helsinki Region Region, Joensuu Region and Oulu Region centres of expertise.

Tampere University of Technology's expertise in material science covers all materials. This broad base of expertise is based on the expertise of institutes that are subordinate to the Department of Materials Science, including the Institute of Materials Science, Institute of Biomaterials, Institute of Fibre Materials Science and Institute of Chemistry. The diversity of the Institute of Material Science's expertise is created in seven subordinate laboratories (Materials Characterisation, Ceramic Materials, Plastics and Elastomer Technology, Surface Engineering, Foundry Institute, Fabrication Technology and Laser Application Laboratory). The Department of Material Science's institutes also co-operate continuously with other Tampere University of Technology departments, institutes, laboratories and units. Tampere University of Technology has profiled itself for years as a university with strong and functional relations to the surrounding society, especially to industry. This can be seen in the large number of national and international research and product development projects carried out together with industry and research institutes. Tampere University of Technology is also bound closely to different regions in Finland. The Institute of Material Science also operates in South Ostrobothnia and Päijät-

Häme through professorships at the Seinäjoki and Lahti university consortiums. Another important co-operation network for Tampere's advanced material research includes the Mikkeli and Kokkola centres of expertise MIKTECH and KETEK.

Tampere's advanced material expertise focuses on advanced composite materials. Expertise in advanced functional composite materials focuses particularly on composites, polymers, surfaces and porous ceramics, areas in which Tampere University of Technology's Institute of Materials Science is an internationally recognised and respected unit. Advanced R&D into functional composite materials is carried out in the following areas: nanosurfaces, porous ceramics, functional surfaces, nanocomposites, hybrid materials, electrically conducting plastics, and rubbers and elastomers. Important R&D work is also carried out by companies in this sector, including Millidyne (functional surfaces), Patria Aerostructures (composites), Suunto (hybrid structures), IonPhase (electrically conducting plastics) and Nokian Tyres (rubbers and elastomers).

VTT's operations in Tampere cover a wide range of industrial sectors and activities, from raw materials to R&D into end products and refined products. Strong experimental research and research equipment ensures the application of future materials. Improving the efficiency of processes and the properties of products are research areas that help improve the competitiveness of existing production plants. VTT's expertise also includes developing new products, methods and processes, as well as clarifying and reducing environmental impacts. VTT's strength is its multidisciplinary expertise, which is used to create solutions for customers. The greatest innovations are often created by networked expertise. The focus of VTT's research includes the functional properties of materials, the sustainable use of natural resources, and conserving nature and materials. The focus areas of VTT's Materials Research Tampere Unit include the electrical properties of polymers, composite materials and developing natural materials.

Through the Tampere Region Centre of Expertise an important national and international co-operation network is active in the cluster. Tampere's and the Tampere Region's leading research expertise in materials science is based on national and international research work carried out together with other universities and research institutes. In Finland these actors include Helsinki University of Technology, the University of Helsinki, Åbo Akademi University, the University of Oulu, Lappeenranta University of Technology, and the University of Joensuu. VTT and its unit are an important national co-operation partner. International co-operation is carried out with many foreign universities and research institutes, for example in the USA, Canada, Russia, Japan, and throughout Europe, including Germany, the Netherlands, Ireland, Spain, France, Italy, Sweden, Norway, the Czech Republic, Slovakia, Hungary, Poland and Estonia. Among the most important of these co-operation partners is the Massachusetts Institute of Technology (MIT), Los Alamos National Laboratory, Oakridge National Laboratory, Argonne National Laboratory, Fraunhofer Institute for Material and Beam Technology, The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology (SINTEF), (RWTH) Aachen University, Ecole Nationale Supérieure de Céramique Industrielle (ENSCI), Academia Górniczo-Hutnicza and the Institute of Chemical Technology.

The Tampere Wear Center (TWC) was founded in 2007 to promote international networking in the field of wear research. TWC's key research partners include the University of Bochum (Germany), the Albany Research Center (USA), CSIRO (Australia) and the Tallinn Technical University (Estonia).

#### Business activities

Research into optoelectronics has created in Finland and primarily in Tampere entirely new industrial activities and several new companies (Coherent Finland, Modulight, EpiCrystals, Corelase, Cavitar, Reflekron) that currently employ over 150 people and whose combined turnover in 2007 exceeded EUR 25 million.

The Laser Competence Centre Finland (LCC Finland) is co-ordinated by the Technology Centre Hermia. Its key research partners are ORC and the Department of Production Engineering at Tampere University of Technology. LCC Finland's activities range from basic technology research along the development chain through integration to the testing of lasers and end-user applications, as well as education and transferring technology to industry. LCC Finland also serves as a co-operation network for companies and university education and research. The centre produces new development projects, including

applied basic research and business projects related to national projects as well as international (EU) projects. LCC Finland supports Finnish companies in global markets by carrying out laser R&D and laser testing, and by continuously seeking new applications and supporting the increased use of lasers. The core group of companies active within LCC Finland represent the laser industry based on research activities. Other important partners include around 40 companies that represent integrators, appliers and end users. LCC Finland is a member of EPIC (European Photonics Industry Consortium) and IVAM (Nano and Micro Technology Network).

Tampere's advanced innovation environment for materials expertise is enhanced by the Tampere Region's strong business environment based on materials expertise. Almost a hundred companies of different sizes whose expertise is based on materials science are active in the Tampere Region alone. The combined turnover of these companies is over EUR 2 billion, and they employ over 10,000 people in the region. Many of these companies operate globally, which creates significant added value for leading expertise created through manufacturing in the Tampere Region. Major companies that have invested in the Tampere Region's materials expertise include Nokia, Metso, Patria, Sandvik, Suominen, Purso, Tamglass, Pilkington, Nokian Tyres, Kvaerner Power, Kiilto and Katsa.

### Goals

The Nanotechnology Cluster Programme supports directly the guidelines of key projects of the City of Tampere and the Council of Tampere Region. The TE Centre has been active in many completed projects with regional development funding and will continue to support similar projects in the future. Other regional key projects and cluster programmes, such as intelligent machines, energy and ubiquitous IT, also support the development of Tampere's areas of expertise within the Nanotechnology Cluster Programme and vice versa.

The goal for photonics and laser technology is to double the turnover of the related industry in the Tampere Region by the end of the decade and to double it again by 2013. The number of companies will be increased through active research and spin-off activities, and the number of jobs will also increase. Photonics and laser technology in their different forms will also increase in mechanical engineering, ICT, biotechnology and other areas, as a result of which their indirect impact on jobs and turnover will be significant, albeit difficult to quantify.

The goal for advanced materials within the centre of expertise is to further strengthen existing industrial expertise and turnover. Within the framework of the centre of expertise programme the goal is also to increase the number of companies that either directly or indirectly utilise the region's strong materials expertise. As expertise is strengthened and business activities expand, the number of jobs is also expected to increase.

## 6. COMMITMENTS

The plan of the Nanotechnology Cluster Programme has been conducted by Jyväskylä Innovation Ltd. Different stakeholder groups have comprehensively participated the planning process.

Commitments to the implementation of the strategic programme have been given by the leading cities, municipalities and regional councils, universities and polytechnics, leading enterprises and regional development companies of the Centres of Expertise.

### Helsinki Region Centre of Expertise



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Uusimaa Regional Council



Eero Holstila  
The City of Helsinki



Erkki KM Leppävuori  
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Helena Elkala  
The City of Espoo



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Mauno Kosonen  
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### Jyväskylä Region Centre of Expertise



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The City of Jyväskylä



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Jykes Ltd



Aino Sallinen  
The University of Jyväskylä



Jussi Halttunen  
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Jouko Yli-Kauppila  
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**Kokkola Region Centre of Expertise**


Altti Seikkula  
Regional Council of Central Ostrobothnia



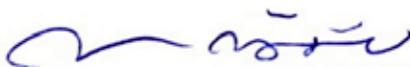
Antti Isotalus  
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Mikael Jakobsson  
The City of Pietarsaari



Mikko Viitasalo  
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Jukka Ylikarjula  
The Federation of Education in Central  
Ostrobothnia



Marja-Liisa Tenhunen  
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Ulf Borg  
Kokkola Industrial Association

**Mikkeli Region Centre of Expertise**


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Regional Council of South-Savo



Kimmo Mikander  
The City of Mikkeli



Markku Lukka  
Lappeenranta University of Technology



Erkki Karppanen  
Mikkeli University of Applied Sciences



Janne-Pekka Surakka  
Savcor Face Ltd



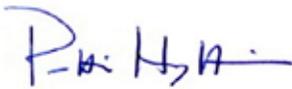
Hannu Salmi  
Environics Ltd

### Oulu Region Centre of Expertise

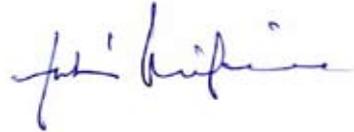


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### North Karelia Centre of Expertise



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Regional Council of North Karelia



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The City of Joensuu



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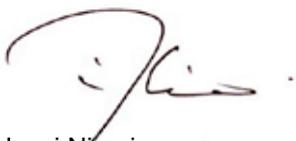


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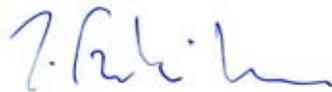
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The Centre of Expertise Programme is a special fixed-term Finnish Government programme to focus work on specific areas of national importance. The concept of the programme is to utilise the international-level expertise in Finland's regions. Thirteen expertise clusters were selected to implement the national programme. The activities of these expertise clusters for the programme period 2007-2013 are based on programme documents prepared together by the regional centres of expertise. The Nanotechnology Expertise Cluster is one of the 13 expertise clusters selected for the programme.

The cluster-based operational model of the programme supports regional specialisation and co-operation between centres of expertise. Each cluster gathers together the key actors within the regional centres of expertise to co-operate in order to implement the cluster programmes. The activities of the clusters and centres of expertise emphasise internationality, attractiveness and accelerating the growth of expertise intensive companies. The cluster-based co-operation also encourages universities and polytechnics to specialise in their strong research areas.