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FINAL ACTIVITY REPORT

A NANOTECHNOLOGY ROADMAP FOR THE FOREST PRODUCTS INDUSTRY

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STFI-Packforsk AB

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Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

1 Project execution

Though industrial exploitation of nanotechnology is still in its infancy, the rate of technology implementation is increasing, not least as a result of the substantial private and public R&D investments directed towards this new field of technology. The estimated worldwide funding for nanotechnology R&D is currently around €5 billion, €2 billion of which comes from private sources. The European Commission has recognized the importance of nanotechnology and in the sixth framework programme, it has been identified as one of the major priorities. In order to stimulate the progress in nanotechnology, the Commission underpins the development of roadmaps as a strategic policy tool in anticipating future developments and planning accordingly.

1.1 Project objective

The objective of NANOFOREST is to outline a research and development roadmap and to recognize new and emerging developments in nanotechnology and related areas suitable for practical application in the forest products sector.

1.2 Contractors involved

The following experts contributed to the report as authors or advisers:

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1.3 Vision

Successful introduction and application of nanotechnology in the refinement of forest-based raw materials will allow production of new generations of innovative and highly value-added materials. Such high-performance materials will exploit the organisation of matter on the nanoscale and will yet be affordable, possible to able to adapt, and benefit a sustainable and competitive industrial development.

1.4 Opportunities

Nanotechnology can be an important tool to promote:

- transformation of the forest product sector from resource-based to knowledge-based, with increased sustainability

- real breakthroughs in the performance of biomaterials produced from forest resources
- a paradigm shift from mass produced single-use fibre products to new concepts of tailored biocomposite materials
- integration of SMEs, for example, as producers of high performance products in bio-refineries together with the pulp and paper industry

1.5 Organization of the Roadmap

The roadmap (Appendix 3) is organized by the major categories of research and development needed to achieve the *Vision*. The major topics are

- Analytical tools
- Wood and wood products
- Pulp, papermaking and packaging
- New materials and composites.
- Education and training
- Environment, safety and health

The process used to reach the conclusions below included “mapping” of new and emerging nanotechnology research and industrial technologies by means of literature surveys, participation in nanotechnology conferences/workshops and visits to focal points for nanotechnology (Appendix 4). To gain a broader input for the roadmap, a workshop with invited participants from industry, government and academia was arranged (Appendix 1) to cover and discuss the major topic areas.

1.6 Conclusions

The main effort in NANOFOREST (Appendix 3) has been to identify the intersections between current and emerging nanotechnology, and tractable areas within the forest products industry sector. The conceptual guidelines used have focused on nanotechnology research and development with regard to wood products, pulp, paper, board and new uses of cellulose fibres. The view has been both on possibilities to increase the performance of more traditional end-products and to perform further product refinements to give new fibre-based platforms for developments targeted to new materials and packaging.

With the focus on near-future applications of nanotechnology in the forest product sector, the following recommendations for research and development areas have been judged most relevant:

- Exploratory research and development in the area of wood and pulp fibre cell wall nanostructure:
 - hierarchical structure including the cell wall pore system,
 - organization and distribution of fibre wall components,
 - enzymatic modification of fibre components,

- chemical and physical modifications of fibre components including loading and modification of the fibre wall pore system.
- Exploratory research and development aimed at the industrial utilisation of cellulose (nano)fibrils:
 - chemical modification of cellulose fibrils,
 - aggregation and deaggregation processes,
 - physical and mechanical characterisation of fibril strength and networking properties in paper and board applications,
 - performance of cellulose fibrils and exfoliated clays in nanocomposites for gas/oil/water barrier applications.
- Exploratory research and development of surface treatments for wood fibres and cellulose (nano) fibrils:
 - polyelectrolyte multi-layering techniques,
 - self-assembly of polysaccharides and polysaccharide derivatives,
 - surface grafting of polymers,
 - block polymers for surface modification.

To address the opportunities and challenges associated with the exploration of nanotechnology, a forest products industry oriented network of European scientists and industry personnel is highly desirable. The advent of new technologies for the characterization of the fibre structure on the nano-level opens hitherto unthought-of opportunities. However, the scientific equipment necessary to reach the desired results is expensive and requires highly skilled personnel, and hence limited in accessibility. Some of the nanotechnology areas are inherently cross-disciplinary and networking can be a means to bring together technology and personnel, creating the intellectual critical mass as well as the necessary cross-disciplinary melting pots. The forest products industry will thus be given an opportunity to increase its awareness of technical and scientific nanotechnology progress in for instance the polymer, biotechnology and microelectronics fields.

2 Dissemination and use

The technology mapping (Appendix 4) performed in the NANOFOREST project has already been a major support in the dissemination activities. During the mapping activity the NANOFOREST roadmap was disseminated and presented at several important nanotechnology centres identified as possible cooperation partners for forest industry related research in the nanotechnology area in.

Currently STFI-Packforsk AB is coordinating the integrated projects (FP6) SUSTAINPACK and ECOTARGET. Relevant applications of nanotechnology for these IPs identified by NANOFOREST will be implemented. Applied nanotechnology is firmly integrated into the activities in the SUSTAINPACK, especially in the subproject aiming at industrial applications of microfibrillar cellulose (MFC). As part of the SUSTAINPACK, a nanofacility site for the production of pilot amounts of MFC also has been set up. These areas have been thoroughly examined in the technology mapping of NANOFOREST.

The NANOFOREST roadmap (Appendix 3) will also be of importance for the definition of strategic objectives in future European projects, such as IPs and STREPs, in the interface between the forest products sector and nanotechnology.