1. PUBLISHABLE SUMMARY

Summary of the context and overall objectives of the project (For the final period, include the conclusions of the action)

The overall objective of the NeoCel project is to develop innovative and techno-economically feasible alkaline dissolving processes for sustainable production of high-quality textile fibres from reactive high-cellulose pulps in connection to pulp mills. The project has developed a novel viable process to produce sustainable textile fibres based on forest resources. The production of the textile fibres currently dominating the market, polyester and cotton, leads to vast environmental impact. Polyester is based on fossil feedstock and cotton leaves a substantial environmental footprint in terms of water consumption, use of fertilizers and pesticides. Along with a growing demand for textiles worldwide due to increased living standard, a demand and need for sustainable alternatives arises. Man-made cellulosic fibres, where cellulose molecules from wood or discarded textiles are extracted, dissolved and regenerated into fibres, has emerged as a viable alternative. But as today's production of such fibres, i.e. viscose and Lyocell, involve explosive and hazardous chemicals, modified or new production routes are necessary. The NeoCel project aims at enhancing the use of cellulose from sustainable sources for material applications with special focus on textiles, and to reduce the environmental impact and occupational health issues related to man-made cellulose fibre production, and thereby promote the availability of sustainably produced, high-quality man-made cellulosic fibres for the textile and fashion industry, and thereby support the shift to a circular bio-based economy. After 3.5 years of research and development, the conclusion is that it is possible to produce sustainable textile fibres from forest resources using the new viable NeoCel process in a techno-economically feasible manner.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far (For the final period please include an overview of the results and their exploitation and dissemination)

With a novel advanced cold alkali-based method to dissolve cellulose as the foundation to produce sustainable textile fibres, the NeoCel project has addressed issues of the individual process stages to eventually cover the whole value-chain from pulp to garment. The major parts of the experimental development have been on cellulose activation and characterization, cellulose dissolution and fibre regeneration as these parts are essential to overcome the current limitations of the cold alkali processes for production of high-quality textile fibres. To reduce the environmental impact and cost of the process, another vital part of the project has been devoted to the system integration with a pulp mill, leading to increased energy efficiency and recovery/regeneration of the process chemicals used for the dissolution and regeneration. By the pulp mill integration of the process, new revenue streams for the mills are presented in addition to the synergistic advantages. To benchmark the developed process against existing manmade regenerated cellulose textile fibre production processes, mainly the viscose process – process simulations and design calculations, as well as life cycle assessment (LCA) have been performed both for the NeoCel process and for a viscose process with the same scenario and constraints (pulp mill integration, located in Sweden etc.).
The major achievements and outcome of the project are:

• Several new pulp adaptation methods to improve the solubility of cellulose in cold alkali, i.e. enhancing the reactivity towards direct dissolution, both via mechano-enzymatic and cooking/

bleaching methods. With the new methods, a wide variety of sequences are available that allow finetuning the desired properties for each specific case (either different pulps or dissolution conditions). The results will be useful for a broad range of stakeholders within the pulping and regenerated cellulose fibre industries. A selection of the results has been published in a peer reviewed paper.

• Two innovative methods for regeneration of process chemicals for each of the two spin bath concepts of the project has gained large interest not only for use in the NeoCel process, but also for existing viscose plants and within the pulping industry. The results were presented at the Avancell conference and will be published in a peer reviewed scientific paper.

• The establishment of continuous mode operation, both for the pulp adaptation process and of the dissolution step. The newly developed dissolution technology not only allows dissolution in continuous mode for large-scale production, but also enables dissolution at more moderate temperatures, which lowers the energy consumption of the production. The results will be published in a peer reviewed scientific paper.

• Development of a new toolbox for more holistic analyses of filaments/fibres. The toolbox gives a new opportunity for better understanding the correlations between the process parameters and the fibre properties on a molecular level.

• The whole value-chain from pulp to garment has been demonstrated and evaluated. By the development of large-scale continuous processes for the mechano-enzymatic pulp pre-treatment and cold alkali cellulose dissolution, kilogram scale production of staple fibres was enabled. The fibres were then utilized for yarn spinning, fabric manufacture, design and production of prototype garments. The importance of this achievement is not limited to enabling prototype production, but also generated valuable data for the process simulations and LCA.

Progress beyond the state of the art, expected results until the end of the project and potential impacts (including the socio-economic impact and the wider societal implications of the project so far)

The project has taken further steps towards developing production of cost-efficient and environmentally friendly textile fibres in Europe. By the concept of integrating textile production with pulp mills, the whole value-chain from forest to garment can be kept within Europe; new market possibilities for local industries are formed and new jobs can be created. The main advantage of the process however is that the toxic chemical CS2 can be omitted from man-made textile production. The chemical is both hazardous to the workers and creates effluents harmful for the environment. The regeneration of process chemicals not only put less burden on environmental factors, but also improves the economic performance of the process. Overall, the process variants developed within the project show considerable advantages when relevant social impact factors like non-fatal accidents, industrial water depletion, social responsibility along the supply chain, biomass consumption and contribution to environmental load are compared to a viscose mill located in China. When compared to a simulation of an optimised viscose mill integrated to a pulp mill in Sweden, the advantages are not as pronounced, however. It is when comparing the results from the LCA, where environmental factors like acidification, water consumption, eutrophication, global warming, fresh water eco toxicity, and human toxicity are considered and compared between the scenarios, that the advantages of the NeoCel process variants become more obvious – especially for the variant utilizing prehydrolysis kraft pulp as feedstock.

Address (URL) of the project's public website

http://neocel.eu/

Managing Director Julia Butuca from Katty Fashion showcasing the NeoCel prototype garments