The New Road to Silk: Bio-based Production of Silk-like Materials

This project is addressing the challenge of how materials can be made in a sustainable way. Plastics that are used today are not sustainable in the long run, partly because of the raw material is fossil, and partly because too much of the plastics end up in the environment despite large efforts on recycling. To create a fully biobased material that both can be made from bio-feedstock and does not accumulate in tour environment, we work on silk as a material. Silk is made of protein which is a polymer. Plastics are also made of polymers, but on a molecular scale these different polymers behave very differently. In the NEWSILK project we combine polymer chemistry and biotechnical silk protein production to understand how silk protein polymers should be processed in order to form new materials such as fibers, adhesives, coatings, or composite structures. In the NEWSILK project we also work together with designers and artists to help communicate our work and to be part of the creative process in developing new concepts for material use when new processes and components open new ways to make materials.

Previously, the studies have been focused on understanding the factors that affect the assemblies formed by the proteins. This knowledge is vital in establishing the relationship between the processing conditions and material properties in order to fabricate products out from the proteins in a large scale. Prior to this project, the effect of various conditions affecting the self-assembly of these particular proteins were largely unknown and significant progress in field has already taken place during the project. The understanding has been supported by computational studies.

Figure 1: In our interdisciplinary collaboration we are looking for new approaches in silk- research (photo Eeva Suorlahti).

In recent months, we have made significant advantages in applying the accumulated knowledge in making of composite materials by combining the renewable protein material with another renewable resource, cellulose, which is the most abundant polymer on Earth. The silk proteins have successfully been utilized as flexible materials in designing of the composites and in adhesions for wood. The biobased systems show a great promise in substituting their oil-based analogues with and their mechanical properties are currently under investigation. The knowledge will be vital in fine-tuning the properties to match the requirements of applications.

In addition to the chemistry and biology, we have a multidisciplinary collaboration between disciplines where textile designers have been" visiting" in the field of synthetic biology, learning to work in the laboratory, pull the fibre and take microscope photos from the fibres. The designers have been inspired by synthetic biology, trying to imagine what these new designed and engineered materials mean for the future. The best term to describe this type of design research is design fiction, which is grounded in utopian design. Design fiction is a method that combines science facts and design, and even science fiction. The idea is to step

outside your own discipline and tie design and science together using a creative narrative, with an aspect of what could be. An exhibition showcasing these ideas will be held in September.

We have been working on the utilization of silk across the scale from fundamental understanding to processing conditions and finally to textile designs. Lately, the focus has been especially on the utilization of the previous fundamental work in applications. Significant advances have been made in all the parts.

More information:

- Professor Markus Linder, Aalto University, (markus.linder(at)aalto.fi)
- Professor Kirsi Niinimäki, Aalto University, (kirsi.niinimaki(at)aalto.fi)
- Professor Heikki Tenhu, University of Helsinki, (heikki.tenhu(at)helsinki.fi)