

Transformation in Resource Use: a Natural Science Perspective

PhD 05b: Chemistry

Sustainable Chemistry within the Textile Sector (Working Title)

Rationale

The work in this perspective focuses on the role and significance of sustainable chemistry in the textile sector, and on the opportunities it holds in general and in relation to the Sustainable Development Goals (SDGs) of the United Nations with a special focus on SDG 6. This PhD research focus on how the framework of sustainable chemistry (Kümmerer and Clark 2016) can to be applied to textile chemistry. Benign by design as one of the fundamental principles of green chemistry (Anastas and Warner 1998, American Chemical Society 2017) is an important part of sustainable chemistry (Kümmerer and Clark 2016) in respect to prevention of water pollution. It will be explored in depth using examples of specific chemicals.

Background / State of Research

Textiles, especially clothing, are a basic need for all humankind. Nowadays textile production occurs primarily in developing countries. Furthermore, there are many economic and social interrelationships between textile production and chemistry, such as workplace safety when handling and disposing of potentially toxic agents. There are about 8 000 different chemicals (also called textile aids, e.g. dyes, process chemicals, softening agents) in use in the textile industries (TEGEWA, <http://www.tegewa.de/infos/textilhilfsmittelkatalog.html>). Additionally manufacturing of textiles needs and pollutes a lot of water. Within the last decades the manufacturing of textiles moved to developing countries for economic reasons. This exacerbated the above-mentioned challenges, e.g. handling and use of toxic chemicals as well as water pollution. A lack of understanding of the role of chemistry nowadays and in future may be seen as one of the reasons for a dissatisfying situation here. From a technical perspective an additional challenge is that there are hardly any effluent treatment plants in place. Often compounds are not biodegradable in the aquatic environment. At the same time there is a shortage of clean water in such countries. Furthermore, such chemicals are imported into the countries where the textiles are bought. In these countries some of the chemicals that are present in and on the textile fibres trigger allergic reactions of the skin when wearing textiles. Later during laundering some of the textile chemicals are also introduced into municipal effluents, and again some of them are not removed even if (advanced) effluent treatment is in place.

Sustainable Chemistry is a broad, overarching approach under development (Kümmerer and Clark 2016) that seeks to overcome the borders between disciplines such as chemistry and economics, ethics and others. It takes into account chemical, economic, social and ethical issues along the whole life cycle of chemicals from resources to end of life of chemicals and chemical products to contribute in a sustainable manner to sustainable development. An improved understanding of the role of sustainable chemistry in general in the context of SDGs as well as for specific sectors such as textile industries is necessary to render sustainable chemistry applicable within the sector of textile to enable chemistry to contribute to sustainable development in a sustainable manner in general. Among other an important building block for the protection of water resources (SDG#6) is the so called benign by design concept (Anastas 1994, Kümmerer 2007, Leder et al. 2015, Rastogi et al. 2015, Haiss et al. 2016). In the given context it aims to render persistent chemicals readily biodegradable and completely mineralizable after their

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introduction into the aquatic environment. And last but not least the source of the fibres is different and will impact environment as well as resource availability for other sectors as well as resources needed for getting the resources for the fibres.

Approach and Research Design

The envisaged research is based on a multi-step approach.

- i) Sustainable chemistry concept and manufacturing of textiles in general.
First the concept of sustainable chemistry will be applied to an example of a textile manufacturing process to assess its applicability and then to identify shortcomings and necessary adaptations in general in the context of textile chemistry. Second, links between sustainable chemistry and SDGs beyond #6 will be explored with the goal of identifying other opportunities to work toward sustainability within the textile sector.
- ii) Application of the benign by design concept to selected textile chemicals.
First the most critical persistent chemicals will be identified. Second the applicability of the benign by design concept for improved environmental biodegradability will be investigated by developing new/modified chemicals. For this purpose computational modelling will be applied to assess the properties of these not-yet synthesized chemicals. Properties include those necessary for the functionality and application in the textile or the manufacturing process, biodegradability to safeguard water resources and toxicity in order to reduce it or avoid it completely to improve workplace safety.
- iii) Developing a communication strategy on sustainable chemistry in textile manufacturing as well as on benign by design as an important building block. Beyond the publication of the results within the scientific communities for proper results, a communication strategy will roughly be developed in cooperation with other PhD students within the Robert-Bosch-research group to disseminate the results within the textile industry with a focus on developing countries but also consumers.

Expected Results

The results of this work will demonstrate and exemplify the role of the concept of sustainable chemistry and its contribution to SDGs within an important industrial sector. By this it presents links to other disciplines too.

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