Sustainable solvents for treatment and recycling of mixed textile fibres

Solvants alternatifs pour le traitement et le recyclage de textiles mélangés

Thesis under the supervision of:

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The textile and clothing industry uses a quarter of all chemicals produced globally and is known to be a large contributor to environmental pollution.[1]

At present the large majority of textile waste is not recycled[2], ending in landfills or being incinerated. Even when natural fibres are used, the environmental impact is considerable – growing new cotton, for example, uses large amounts of water, farmland and pesticides. Furthermore, the textile industry uses pigments and additives that find their way into the environment when a garment is disposed of. In order to improve sustainability, the major corporations in the textiles sector seek to develop technologies to move from linear to circular production processes[3]. One challenge for recycling is being able to separate cotton or synthetics without resorting to extremely harsh chemicals and process conditions, and also without downgrading the quality of reprocessed fibres or the additives or pigments used. Persistent pollutant additives, like fluorinated compounds in technical garments, can be destroyed chemically once they are extracted from the fibres while the pigments can be reused. The recycled cotton or synthetic fibre can then be recycled with no additives left.

In this project we explore the design of alternative, environmentally acceptable solvents to carry out separations to improve the recycling process of fibres in the textile industry. The use of ionic liquids and their (eutectic) mixtures will be explored as they have proven to be good solvents not only for cotton[4,5] but also for fibre pigments[6] or additives in mild conditions.

In order to advance our understanding of fundamental aspects of physical chemistry related to the solvation mechanisms of the different materials used in the textile industry, both experiments (spectroscopy, dissolution, interfacial properties) and molecular simulations at different scales will be used. The aim is to characterise the interactions between the polymers or the additives and the ionic solvents. We will work on the

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[1] Schellenberger, S. *et al.*, *J. Cleaner Prod.* **2019**, 217, 134-143.
[2] Hawley, J. M. Apparel recycling. In *Sustainable Apparel*; Blackburn, R., Ed.; Woodhead Publishing, Elsevier: Cambridge, 2015; pp 251–262.
[3] McDonough, W. *et al., Environ. Sci. Technol.* **2003**, *37* (23), 434A–441A.
[4] Swatloski, R. *et al., J. Am. Chem. Soc.* **2002**, *124* (18), 4974–4975.
[5] Andanson, J.-M *et al., Green Chem.* **2014**, *16* (5), 2528–2538
[6] Bianchini, R. *et al.*, *ACS Sustainable Chem. Eng.* 2015, 3, 2303−2308.

molecular nature and composition of the ionic media aiming to improve their performance in dissolution and separation processes as well as to reduce their environmental impact. The outcome of this project can bring major benefits for a more sustainable textiles industry.

The project will be carried out in the *Laboratoire de Chimie de l'ENS Lyon* in the Theoretical Chemistry and Molecular Thermodynamics group and the candidate will interact with an active international network of collaborators in the field of sustainable chemistry and ionic liquids.

Suitable candidates hold a Master or an engineering degree and have skills in physical and/or computational chemistry. A good level of both oral and written English is required.