SUPERCRITICAL CARBON DIOXIDE: A SUSTAINABLE MEDIUM FOR TEXTILE DYEING AND FINISHING TO EXPAND THE POSSIBILITIES FOR A RESOURCE EFFICIENT PRODUCTION TECHNOLOGY

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In our research group focusing on resource efficient processes, we explore the waterless supercritical carbon dioxide (SC-CO_2) technology as a promising sustainable alternative to the traditional textile wet dyeing and water based finishing processes. Already, it is industrially implemented for textile dyeing, in particular for synthetic fabrics, and, being a dry color process it is regarded as only using ¼ of the physical footprint compared to conventional dyeing. This, does not only account for water and energy savings, but also includes advantages such as reduced emissions of harmful effluents, less amount of used dye, no or minimal use of auxiliaries (dispersing agents, carriers and surfactants) and low waste of material. To expand the industrial capabilities of this technology and open up for new business opportunities, our research focuses on textile functionalization in SC-CO_2, either by only applying a functional material or to combine dyeing and functionalization of fabric in a single-step process. For polyethylene terephthalate (PET) fabric dyeing (step 1) and functionalization (step 2) in a sequential process where similar processing parameters (high temperature and pressure) was used, it was found that the color was extracted in the second step. The PET dyeing kinetics using SC-CO_2 as a solvent depend on the transition in the amorphous regions of the fiber and diffusion properties and solvating power of the SC-CO_2 with the dye. Hence, extensive studies on compatibility between fiber, dye and functional compounds include solubility of dye and functional material in SC-CO_2, optimization of process parameters (pressure and temperature) and depressurization. This is crucial for understanding the adhesion mechanism between fiber and chemicals, and, particularly for a proper adhesion with a durable functional performance. Furthermore, as SC-CO_2 is a good solvent for hydrophobic compounds, nonionics and organic compounds with low molecules weight, there are challenges in modifying conventional compound or using co-solvents. Activities within this domain in our research group stretch between dyeing and functionalization of textiles with end-use properties such as antimicrobial, photochromic, moisture management, water repellency, soil repellency and flame retardant.

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