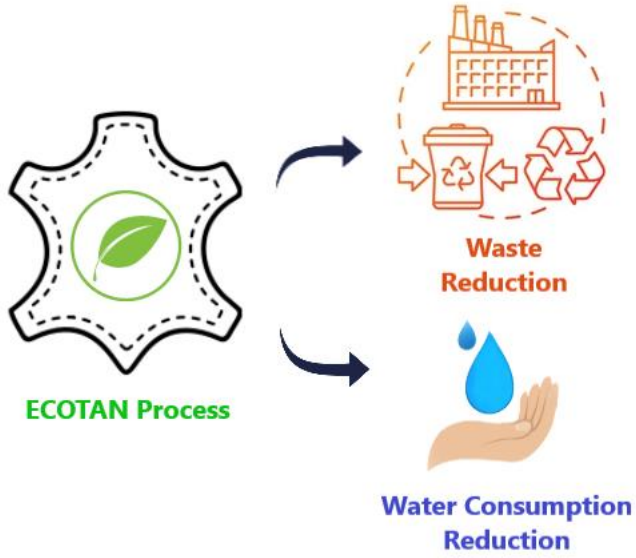
“ECOTAN” NEW SUSTAINABLE PROCESS FOR THE LEATHER INDUSTRY

Michela Volgare – Advisor: Prof. Paolo Antonio Netti

Curriculum: Ingegneria dei Materiali e delle Strutture



The leather processing goes through several steps, including the tanning process, conducted in an aqueous environment in which water is used as a fundamental resource for the chemical transformation of hides. Due to the diffusive transport mechanisms, the transformations are slow and ineffective. To improve the process, tanning agents are used in large excess respect to the theoretical value. In addition, it has been reported that the recommended average water consumption is around 30-50 L per kg of treated skin [1–3], sometimes it is observed that in a tanning process water consumption is higher, and in some cases it rises to an average of 142 L/kg up to 150 L/kg [2]. In 2018, 10,000 tonnes of leather were sold in Italy [4], estimating about 500 million litres of wastewater are produced per year. In view of a green innovation, we want to implement a water-less, or water-free, process with low environmental impact, by developing an advanced tanning technology. The development of this technology could achieve a significant reduction in the water resources used and a total depletion of chemical agents, resulting in a reduction in water pollution and wastewater purification costs. The aim of this project is to develop innovative products through the industrial implementation of a sustainable tanning process without the use of water as a vehicle for tanning agents (water-free) or with a substantial reduction of water amount used in the whole process (water-less), in combination with the use of alternative metal-free tanning agents [5–7].

Moreover, the manipulation of the animal skin allows the absorption of macromolecular and nanoparticle compounds, difficult to use with conventional processes that do not allow their effective penetration. Polymers and nanoparticles modulate and amplify the properties of the skin, giving innovative functions. The employing of a three-dimensional material leads to the possibility of creating substrates with amplified characteristics of resistance to hydrolytic attack, resistance to tearing and abrasion, with the aid of surface treatments and "three-dimensional" treatments to give the

skin different peculiarities. With the application of ad hoc functionalization it could get genuine leather with superhydrophobic properties, inspirated by superhydrophobic surfaces comes from nature, e.g. lotus leaf, butterfly wings, scales of sharks, gecko foot and pond skater [8], and with remarkable mechanical properties, in terms of tear load, tensile strength and elastic modulus [9].

Bibliography

1. Hutton M, Shafahi M. Water pollution caused by leather industry: A review. *ASME 2019 13th Int Conf Energy Sustain ES 2019, collocated with ASME 2019 Heat Transf Summer Conf*. 2019;(December). doi:10.1115/ES2019-3949

2. Haydar S, Asif Z, Bhatti AA, Nadeem O, Hussain G, Abbas N. Efficiency of Wastewater Treatment Plant in the Punjab Tannery Sector: a Case Study of Dada Tannery. *J Engg Appl Sci*. 2015;34(1):1-14.

3. Sundar VJ, Ramesh R, Rao PS, Saravanan P, Sridharnath B, Muralidharan C. Water management in leather industry. *J Sci Ind Res (India)*. 2001;60(6):443-450.

4. UNIC. Rapporto di sostenibilità 2018 - LA STORIA CONTINUA. *J Chem Inf Model*. Published online 2018.

5. Velmurugan P, Singam ERA, Jonnalagadda RR, Subramanian V. Investigation on interaction of tannic acid with type i collagen and its effect on thermal, enzymatic, and conformational stability for tissue engineering applications. *Biopolymers*. 2014;101(5):471-483. doi:10.1002/bip.22405

6. Beghetto V, Agostinis L, Taffarello R, Samiolo R. Innovative active cross-linking agents for sustainable leather manufacturing. *Smart Innov Syst Technol*. 2016;52:149-155. doi:10.1007/978-3-319-32098-4_13

7. Greco K V., Francis L, Huang H, Ploeg R, Boccaccini AR, Ansari T. Is quercetin an alternative natural crosslinking agent to genipin for long-term dermal scaffolds implantation? *J Tissue Eng Regen Med*. 2018;12(3):e1716-e1724. doi:10.1002/term.2338

8. Meena MK, Tudu BK, Kumar A, Bhushan B. Development of polyurethane-based superhydrophobic coatings on steel surfaces. *Philos Trans R Soc A Math Phys Eng Sci*. 2020;378(2167). doi:10.1098/rsta.2019.0446

9. Xu W, Zhou J, Wang Y, Shi B. Modification of Leather Split by in Situ Polymerization of Acrylates. *Int J Polym Sci*. 2016;2016. doi:10.1155/2016/7460572

Michela Volgare, PhD student XXXVII cycle, July 2022