

High-performing bio-based surfactants from renewable waste streams for the circular economy

Surfactants are among the unsung heroes of the modern chemical industry. These often overlooked yet vital groups of chemicals impact almost every segment of our daily lives. Due to their amphiphilic nature, these compounds help to mix hydrophobic and hydrophilic substances (e.g. water and oil) by reducing the interfacial tension, making them key ingredients in a wide range of products. They are widely used not only in laundry detergent, household- and professional cleaners but also in personal care products and cosmetics, as well as in pharmaceuticals, paints, dyes, pesticides and the textile and leather industries.

Given their widespread use, it is no surprise that around 19 million tons of surfactants are produced worldwide every year. However, almost half of these products are still made from petroleum, and only less than 5% are made entirely from renewable resources. Given the chemical industry's need to reduce carbon emissions to mitigate the effects of climate change and the increasing

demand of end-users for sustainable products in this industrial sector, surfactant manufacturers and product formulators alike are under tremendous pressure to find suitable alternatives to the compounds currently used and in production.

The current generation of fully bio-based surfactants, whether chemically synthesised or microbially produced, are recognised for their mildness, reduced aquatic toxicity and high biodegradability. However, their large-scale adoption is partially limited either by their cost, inherent instability, formulation or discrepancy in performance compared to industrialised partially bio-based and petroleum-derived surfactants.

Aims and objectives of PureSurf

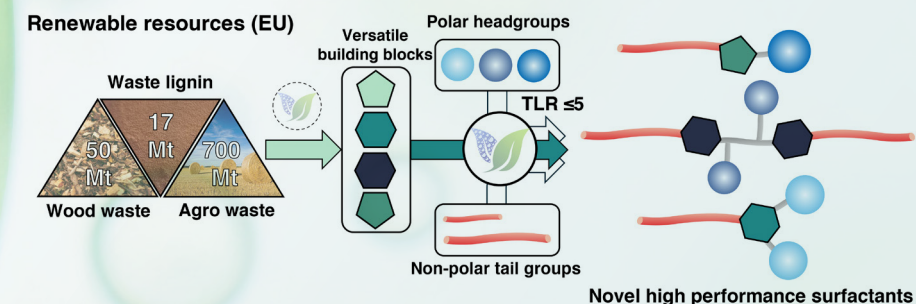
The EIC Transition-funded PureSurf project aims to bridge a critical gap—connecting abundant but underutilised local renewable resources with the industry's and consumers' demand

for cost-effective, sustainable, high-performance bio-based surfactants. To achieve this, the project is focusing on:

- feedstock flexibility, ensuring diverse and renewable raw materials can be used
- product performance, optimising surfactants for real-world formulations
- process robustness and scalability, making production efficient and commercially viable
- environmental impact, assessing biodegradation and ecotoxicity for a sustainable solution.

Significant results

A core philosophy of the project is to embrace the natural complexity of renewable building blocks, like bio-based aromatics. Viewing the inherent structural features not as obstacles but rather opportunities for efficient and selective chemical conversions allows for the synthetic flexibility of the PureSurf platform. Therefore, a library



of novel surfactants was created by using highly functionalised renewable building blocks as spacers between the polar head group and the non-polar tail group of the final surfactant.

To date, more than 80 novel surfactants have been developed, using building blocks derived from abundant and underutilised renewable raw materials, such as agricultural-, food- and wood wastes, as well as technical lignin. These include anionic, cationic, zwitterionic and non-ionic surfactants, with the current focus on anionics and zwitterionics, namely amine oxide-, amino acid- and sulphonate-based surfactants.

The previously described approach allows PureSurf to produce novel surfactants that exhibit favourable properties compared to both currently available bio-based as well as petrol-based alternatives. For example, a selected PureSurf amine oxide achieves *inter alia* an eight times lower interfacial tension (water-oil) at 1 wt% surfactant loading, and up to 17 times lower critical micelle concentration, with six times higher foam stability at, e.g. one fourth of the acute toxicity against invertebrates (*A. fischeri*) compared to N,N, dimethyldodecan-1-amine N-oxide, one of the most prominent zwitterionic surfactants.

Additionally, the inherent antimicrobial properties of lignin and the monomers that can be obtained from it via various depolymerisation techniques have been exploited to produce novel renewable quaternary ammonium-based disinfectants. Hereby, selected candidates can outcompete benzalkonium chloride, cetyl ammonium bromide as well as chlorhexidine against both Gram-negative (*B. subtilis*) and Gram-positive (*S. aureus*) bacteria in both lab and real-life conditions.

Of those, selected candidates have scaled up to the kg scale to provide sufficient sample quantities for interested pilot customers. Hereby, the first formulations have already been developed: a general-purpose hard surface cleaner, a foam cleaner and a general surface disinfectant.

To be continued

PureSurf has achieved significant milestones in the production of high-value-added surfactants from underutilised renewable resources. PureSurf recently won two prizes at the SPG Startup Idea Competition 2025, both in the category 'Health' and 'Most positive climate impact'. To properly exploit the results of the EIC Transition Project, further patents are being filed, and a spin-off company is being established, whose co-founders will include scientists currently working on the project and an external industry expert. The capabilities of the platform will be further explored scientifically within the recently started Horizon Europe project RADAR: *Renewable and safe Aromatic compoundDs As Replacements for substances of concern* (GA No. 101178148) as well as a recently funded CBE JU project.

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 Sources [click here](#)

PROJECT NAME

PureSurf

PROJECT SUMMARY

The EIC Transition project PureSurf aims to bridge the gap between abundant renewable resources and the demand for sustainable, affordable, high-performance surfactants. Guided by the inherent structural features of renewable building blocks and green chemistry principles, a library of over 80 novel compounds has been generated that show significant performance improvements over their industrialised counterparts.

PROJECT LEAD PROFILE

Professor Barta Weissert is a leading academic expert in the fields of green chemistry, catalysis, and renewable resources. She has a strong international background, having trained at RWTH Aachen University, the University of California, Santa Barbara, and Yale University. She has held an independent academic position since 2013 at the Stratingh Institute for Chemistry in Groningen, and is currently a full professor at the University of Graz.

She is the elected Secretary of the EuChemS Division of Green and Sustainable Chemistry, a member of the Young Academy of Europe, and Chair of the Editorial Board of *ChemSusChem*. Her awards include an ERC Starting Grant (2015), a VIDI Grant (2015), an ERC Proof of Concept Grant (2019), an EIC Transition Grant (2021) and an ERC Consolidator Grant (2023). She also received the 2019 NCCC Award and the 2020 ACS Sustainable Chemistry & Engineering Lectureship Award.

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Fact.MR (n.d.) *Surfactants market*. Fact.MR. Available at: <https://www.factmr.com/report/surfactants-market>.

Marchant, R. and Banat, I.M. (2012) 'Microbial biosurfactants: challenges and opportunities for future exploitation', *Trends in Biotechnology*, 30(11), pp. 558–565. doi: [10.1016/j.tibtech.2012.07.003](https://doi.org/10.1016/j.tibtech.2012.07.003).

Mordor Intelligence (n.d.) *Surfactants market size – industry report on share, growth trends & forecasts analysis (2025–2030)*. Mordor Intelligence. Available at: <https://www.mordorintelligence.com/industry-reports/surfactants-market>.

Nagtode, V.S., Cardoza, C., Yasin, H.K.A., Mali, S.N., Tambe, S.M., Roy, P., Singh, K., Goel, A., Amin, P.D., Thorat, B.R., Cruz, J.N. and Pratap, A.P. (2023) 'Green surfactants (biosurfactants): a petroleum-free substitute for sustainability—comparison, applications, market, and future prospects', *ACS Omega*, 8(13), pp. 11674–11699. doi: [10.1021/acsomega.3c00591](https://doi.org/10.1021/acsomega.3c00591).

Porter, M.R. (1991) *Handbook of surfactants*. New York: Springer. doi: [10.1007/978-1-4757-1293-3](https://doi.org/10.1007/978-1-4757-1293-3).

Romero, G. and Gallo, P. (2024) 'Bio-based surfactants and biosurfactants: an overview and main characteristics', *Molecules*, 30(4), 863. doi: [10.3390/molecules30040863](https://doi.org/10.3390/molecules30040863).

Tadros, T.F. (2005) *Applied surfactants: principles and applications*. Weinheim: Wiley-VCH. doi: [10.1002/3527604812](https://doi.org/10.1002/3527604812).

Zargar, A.N., Kumar, M. and Srivastava, P. (2023) 'Biosurfactants: challenges and future outlooks', in Aslam, R., Mobin, M., Aslam, J. and Zehra, S. (eds) *Advancements in biosurfactants research*. Cham: Springer International Publishing, pp. 551–576. doi: [10.1007/978-3-031-21682-4_25](https://doi.org/10.1007/978-3-031-21682-4_25).