RESEARCH PROJECT

“Smart rust makes clean water”

LUKAS MÜLLER

Elite Graduate Program “Advanced Materials and Processes”

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Magnetic particles for water cleaning

Lukas Müller graduated in the Elite Graduate Program “Advanced Materials and Processes” (MAP) from Friedrich-Alexander-Universität Erlangen-Nürnberg. Therefore, he worked for a study-related project at the group of Prof. Marcus Halik, where he investigated on iron oxide nanoparticles to clean water from nanoplastics. Based on this, he is now conducting his PhD in the group with scholarship support from the Deutsche Bundesstiftung Umwelt. He focuses on cleaning molecular pollutants from water.

Anthropogenic molecules pollute our water

Access to clean water is recognized as a human right by the UN. However, anthropogenic organic pollutants, like herbicides, hormones or antibiotics are present in our ground water and potentially find their way into drinking water due to careless disposal and insufficient remediation. Already at the trace concentration level such compounds have been shown to have severe effects on aquatic flora and fauna, but also to us humans, especially children. Still consequences of long term exposure are often unknown.

Therefore, it exists a big demand in affordable and efficient removal of such organic contaminants from water. Having this in mind, Lukas functionalizes superparamagnetic iron oxide nanoparticles (SPIONs) with self-assembled monolayers (SAMs) composed of phosphonic acids to address certain interaction motifs of selected pollutants (“smart rust”). Such core-shell particles may attract the pollutants and can be easily remediated from water by an external magnetic field due to the magnetic moment of its cores.

The whole is greater than the sum of its parts

While previous approaches of the group only rely on a single major interaction motif (covalent binding, electrostatic interactions or hydrophobic interaction), Lukas and colleagues are currently establishing the next logical step. In his doctorate he tries to understand and establish the interaction of rationally designed mixed SAMs on SPIONs with dedicated trace organic pollutants (e.g. various steroidal hormones). Therefore, the group envisions systems that are not only thermodynamically attractive for the pollutants of choice, but also present suitably-sized cavities in the mixed SAM that enable a favorable binding of the whole approached pollutant family in comparison to other organic or inorganic matter. The project inherently profits from synergy of experimental materials science, analytical chemistry and molecular simulation. Therefore, the Elite Master’s Programme MAP prepared Lukas very well not only in getting contact with cutting-edge research but also formed the necessary scientific background to tackle such complex problems.