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ONLINE MICROPOLLUTANT ANALYSIS SYSTEM FOR EFFICIENT WASTE WATER TREATMENT

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Anthropogenic micropollutants, such as drugs or pesticides, are increasingly found in the water cycle. These contaminants, which are invisible to the human eye, can only be removed incompletely with existing waste water treatment processes and pose new challenges for waste water treatment plant operators. A fourth treatment stage is intended to remedy this situation. However, the intended treatment with activated carbon or ozonation has not yet been tailored to demand and is thus not economical. This is mainly due to a lack of process monitoring. The available analytical methods for determining the concentration of trace substances, such as chromatography, are not suitable for on-site use, partly because they incur high laboratory preparation costs. In order to close this monitoring gap, the BMBF joint project "ANTHROPLAS" has developed on-site analysis for efficient waste water treatment.

The core element of the new pollutant analysis is an optical sensor chip (Figure 1) based on a nanostructured gold layer, developed by Fraunhofer IKTS. The nanostructuring makes it possible to excite surface plasmons (electron oscillations) in the gold layer with a LED. Complex optics are no longer needed, which results in a much more compact analyzer. In addition, the surface plasmons display a highly sensitive reaction to molecular bonds – a prerequisite for detecting micropollutants.

The greatest challenge in the detection of pollutants lies in the measurement of low concentrations in the µg/L range. For this reason, a protocol was developed which measures a directed reaction of antibodies (recognition structure) with the micropollutant in question. The gold surface is biochemically activated for this purpose. If a certain pollutant is present in the waste water, an immune reaction with antibodies is triggered. As a result, the optical properties of the gold nanostructure change, which ultimately provides information about the presence and concentration of the micropollutant that is being searched for.

The online-capable analyzer with automated measuring sequence (Figure 2) was set up by the industrial partners and tested successfully in the laboratory at Fraunhofer IKTS. As an example, the concentration of the pollutant diclofenac was determined in a range from 0.1 to 10 µg/L with a measuring cycle of 15 minutes. The sensor chip could be reused more than 100 times. In a last step, the analyzer was integrated in a waste water treatment plant.

In the future, the online micropollutant analysis system will be used to check compliance with limit values both directly at the waste water treatment plant and in water bodies. By adjusting the functionalization, it is possible to detect any micropollutant. In addition to the upcoming long-term tests under real conditions, standardizing the analysis process is aimed for.

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1 *Biosensor chip, e.g. for determining diclofenac concentration in waste water.*
2 *Online analyzer to be installed in the 4th treatment stage of waste water treatment plants.*

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