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Extract from the annual report 2020
To the website: www.ist.fraunhofer.de/en.html

MODEL CALCULATIONS FOR THE DEGRADATION OF NITROGEN OXIDES BY MEANS OF PHOTOCATALYSIS

Over the course of the corona pandemic, a considerable reduction in road traffic has occurred and, as a result, nitrogen dioxide (NO_2) emissions have fallen sharply. Since the end of the lockdown in mid-April 2020, significant increases have, however, already been recorded. Looking back to the year 2019, the annual average limit value for NO_2 of 40 µg/m³ air was exceeded at around 20 percent of the measuring stations in Germany, which are located close to traffic – despite the fact that diesel driving bans were already in force and environmental zones had been established. In comparison, in 2018 this figure was still 42 percent of the stations.

For many years, the Fraunhofer IST has been working on the development of surfaces which, when equipped with photocatalytic activity, can contribute to the reduction of air pollutants. Particularly in urban environments, large built-up areas are available for this purpose. In collaboration with the Ostfalia University of Applied Sciences in Wolfenbüttel, a study was therefore initiated within the framework of a master's thesis with the aim of applying numerical simulation to determine the degradation potential of photocatalytically equipped surfaces for nitrogen oxide reduction. For this purpose, the model of a real street canyon on the premises of the Fraunhofer IST was selected, as, firstly, the pollutants are poorly removed here under certain wind conditions and, secondly, sufficient surfaces are available which can potentially be equipped with photocatalytic properties.

The method

As an evaluation parameter for the photocatalytic activity, the photocatalytic deposition velocity of nitrogen monoxide (NO) was determined in the laboratory in accordance with prEN 16980-1:2020 for a number of commercially available building products such as glass, concrete paving stones and roughcast. These values were then used to calculate the photocatalytic resistance, which in turn is an essential parameter for atmospheric dispersion calculations. Taking into account meteorological data on wind flow and solar radiation, the values of the photocatalytic resistance served as input variables in the investigation in which the programs LASAT (Lagrange Simulation of Aerosol Transport for the simulation of the dispersion of pollutants in the atmosphere) and WinMISKAM (prognostic microscale flow and dispersion model for Windows) were utilized in order to simulate the reduction of NO_x concentrations on basis of the year 2018 using the example of the street canyon on the premises of the Fraunhofer IST (see Figure 1 and 2).

Improving air quality through photocatalysis

The results showed that, assuming a complete photocatalytic equipping of road, façade and roof, the annual average NO_x concentrations can be reduced by 1 to 2 percent, even at low deposition rates of 0.14 cm/s. By using high-performance photocatalytic building materials with average deposition rates of up to 1.50 cm/s, such as those developed in the BMBF joint project "PureBau", the NO_x emissions can be reduced by an

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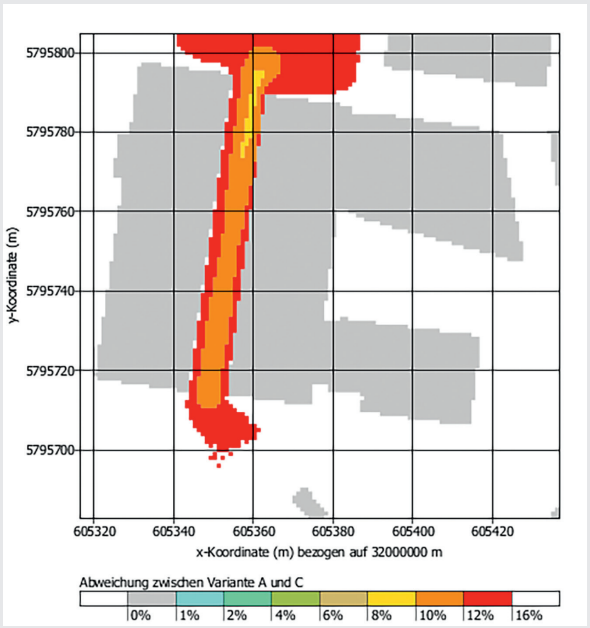
1 *Model canyon on the premises of the Fraunhofer IST in Braunschweig.*
2 *ArcMap model sketch.*
3 *Percentage reduction of NO_x emissions in the photocatalytically active model canyon.*

average of 10 to 12 percent (see Figure 2). The degradation rates thereby fluctuate between 2 and 4 percent in winter and between 16 and 18.5 percent on typical summer days.

Photocatalysis can therefore verifiably provide a decisive contribution towards the improvement of air quality in our city centers, even in areas of the republic, which experience less sunshine.

Outlook

Within the scope of an expansion of the laboratory capacities, the measurement technology available at the Fraunhofer IST is being expanded to include the possibility of determining the photocatalytic deposition rates of nitrogen dioxide (NO_2) and ozone (O_3) in order to be able to determine the atmospheric input variables even more precisely. Parallel to this, the IST, as a member of the DIN standards committee Photocatalysis, supports the development of future test standards in this field and will therefore be able to offer its customers a comprehensive range of services in the future for the evaluation of their photocatalytically active products – from the material through to the application.



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