Viability of TiO_2-Based Self-Cleaning Glass: What Can be Deduced from Prolonged Field Experiments and Life Cycle Assessment?

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On the basis that the TiO_2 photocatalytic degradation of most organic compounds (including microorganisms, to some extent) was demonstrated and that the TiO_2 UV-induced hydrophilicity made the rainwater droplets to form a film on the surface, several glass manufacturers have commercialized TiO_2-based self-cleaning glass. This author has presented an overview [1] regarding the fundamentals, the TiO_2 coating techniques, the optical and mechanical properties, the evaluation and limitations of the self-cleaning efficacy and the factors influencing it. The claimed impact on outdoor air quality was also briefly discussed [1] and further challenged because it would be intrinsically very localized [2]. Given the concern about nanoparticles, the potential health risk was analyzed in a survey [3].

The self-cleaning efficacy of glass either commercial or made by diverse research groups has most often been evaluated via laboratory experiments using various artificial deposits, which have not always been appropriately selected. Obviously, field experiments were much rarer and chiefly corresponded to relatively short time periods. This communication will focus on the conclusions that could be drawn from prolonged field experiments [4,5] and Life Cycle Assessment (LCA) [6].

A controlled 8-year exposure of TiO_2-coated commercial glass plates in a big city at a height of 40 m and a 45° incline [4] cast some doubt on the performance regarding the use for window panes because, above all, in rain exposure, no self-cleaning significant difference with regular glass was observed, and, under shelter, the initially positive effect became negative beyond ~4 years as a result of the expected TiO_2-generated formation of inorganic salts on the surface. Concerning the use of self-cleaning glass as a cover of photovoltaic cells, large-scale 7-month field experiments under two very distinct climates [5], showed increases in the electric power output thought to be encouraging, particularly when the solar irradiation was low. Because industrially managed photovoltaic plants should allow one to determine the right trade-off between the recorded declines in the electricity produced over time and the expenses of the needed cleanings, this use of TiO_2-coated glass could be of interest.

The parameters of the LCA of self-cleaning glass include the energy and materials consumed, the emissions and wastes generated, during the manufacturing, the installation, the use and the final discarding [6]. Assumptions leading to uncertainties are unavoidable. However, the objective is to determine the most important parameters and stages. For example, it would help to foresee after how many cleanings, the energy consumed, primarily for the coating production, would be outweighed. Additionally, the contribution to the climate change must also be considered, especially if the energy is obtained from fossil fuels. The present LCA studies call into question the viability of TiO_2-coated glass, at least for windows, both economically and environmentally

[6]. Revisions should be made after introducing more favorable parameters, e.g. regarding the energy sources.

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