Supporting Information

Emission of Titanium dioxide nanoparticles from building materials to the environment by wear and weather

*Neeraj Shandilya, Olivier Le Bihan, Christophe Bressot, Martin Morgeneyer*

Microscopic analysis of the nanocoating solution, uncoated brick and the Taber™ H38 abradant

TEM analysis of the nanocoating solution was carried out using drop deposition technique (described in the section 2). The result is shown in figure 1 (a). The two phase agglomerates of the deposited particles from the nanocoating can be observed. These two phases are contributed by the polymer matrix (in grey color) and incorporated TiO₂ nanoparticles (in pitch black color). The average TiO₂ particle size is measured to be 8 ± 4 nm. The Energy-dispersive X-ray analysis (EDX; Model X-max; Oxford Instruments UK) of the elemental composition of the nanocoating show the following: C (60 to 65% in mass), O (15 to 20% in mass) and Ti (10 to 15% in mass). In figures 1 (b) and (c), SEM images of the uncoated brick reference and the Taber H38 abradant are shown. Rough surfaces (r.m.s. roughness for brick: 26 µm; r.m.s. roughness for abradant: 4 µm) can be observed.

(a) 50 nm  
(b) 50 nm
Microscopic analysis of leachate water

When the leachate water samples were analyzed using TEM, various irregularly shaped particle agglomerates, in micro size ranges, were observed (figure 2 (a) and (b)). In coherence with the ICP-MS measurements, the EDX analysis of these particle agglomerates (figure 2 (c), (d) and (e)) showed an overall increasing Ca content, from 3 to 17% (by mass), with weathering duration. A meager Ti content (0.2-1%, by mass) was observed in all grids. The C content (from nanocoating copolymer) was found to be varying from 3 to 10% by mass. The other dominating elements were Si (~32%, by mass) and Al (~20%, by mass).

Figure S2. TEM analysis of (a) & (b) Particle agglomerates present in the leachate water sample; Average chemical spectrum of the leachate water sample obtained after (c) 2 months (d) 4 months (e) 7 months of weathering
Effect of weathering on uncoated brick reference

In figure 3, optical microscopic images of 3 different surface spots, on a 7 months weathered uncoated reference sample, are shown. Opposed to the nanocoated surfaces, no effect of weathering (i.e. cracking or lumping) is visible.

Figure S3. Optical microscopic images of different spots on the surface of 7 months weathered uncoated reference sample

Drop deposition technique

For the TEM analysis, first a diluted solution of the sample was prepared (1% by volume for the nanocoating, no dilution for the leachate sample). A drop (8 µl approx.) from this diluted solution was deposited onto a TEM copper mesh grid (Model S143-3; Quantifoil Micro Tools GmbH Germany). The mesh grid was made hydrophilic by its plasma treatment- 0.1 mbar, 45 mA, 3 min- (Model K100X, Glow Discharge, Emitech, Quorum Technologies Ltd. UK) prior to drop deposition. After the deposition, the grid was then allowed to dry in a closed chamber so that the water content gets evaporated and the constituent particles rest deposited on the grid.