

TiO₂ nanoparticles release from a photocatalytic coating for roads due to weathering and wheels abrasion



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THE CASE STUDY



Air pollution: Half a million early deaths in Europe despite progress

29 October 2018

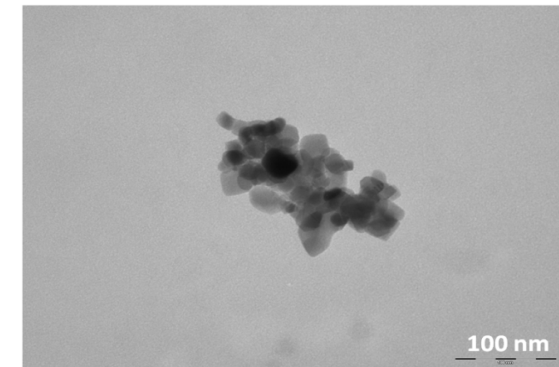
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Air pollution causes almost 500,000 premature deaths in Europe every year, the European Environment Agency (EEA) has warned.

Air pollution is said to be the main cause for premature deaths across Europe

THE CASE STUDY



TiO₂ nanoparticles

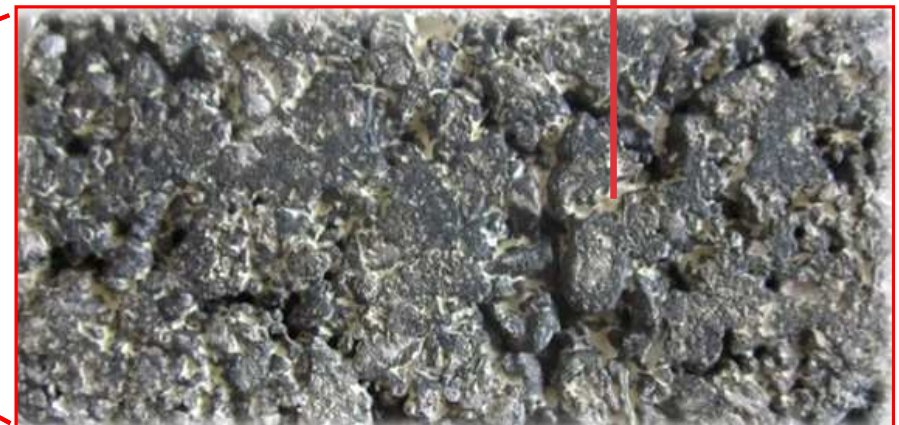
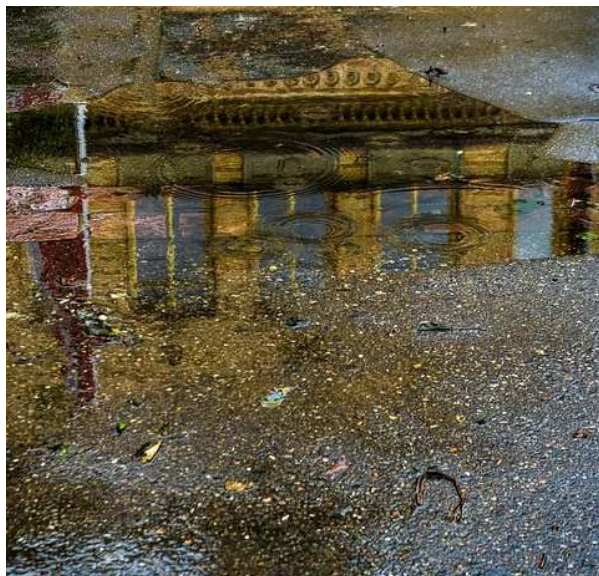
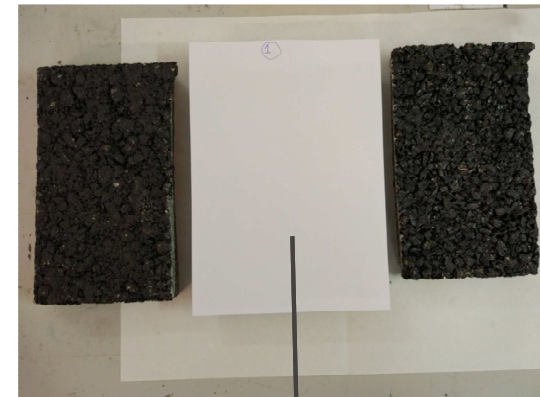
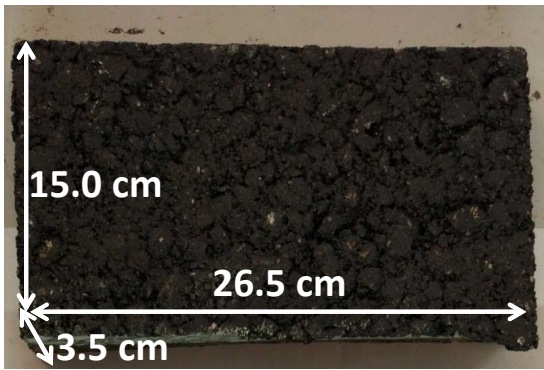


Figure obtained from EQUINOX project

POTENTIAL ENVIRONMENTAL IMPACT



METHODOLOGY



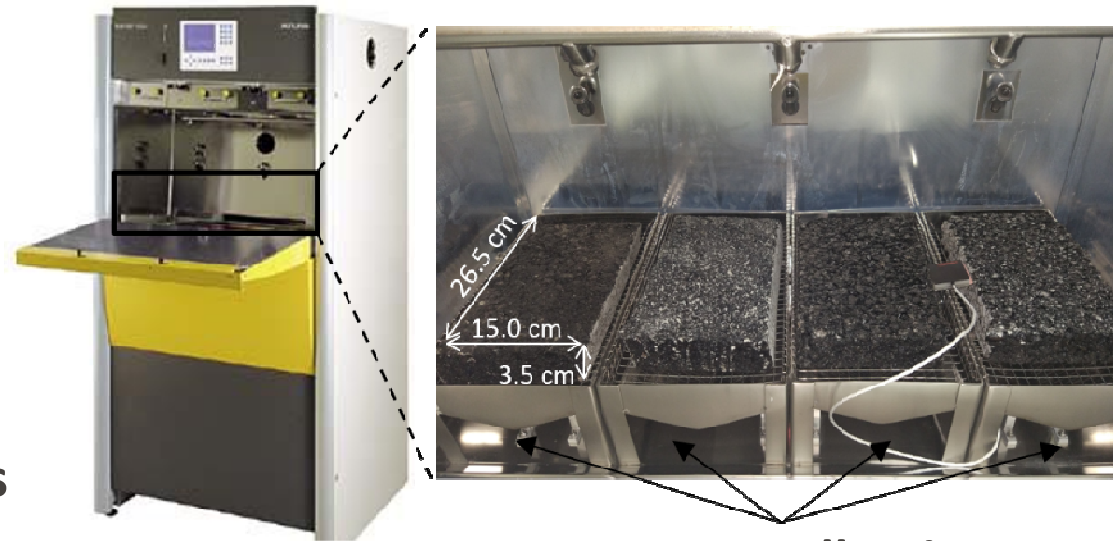
Electronic
microscopy → SIZE

X-ray diffraction →
CRYSTALLOGRAPHIC PHASE

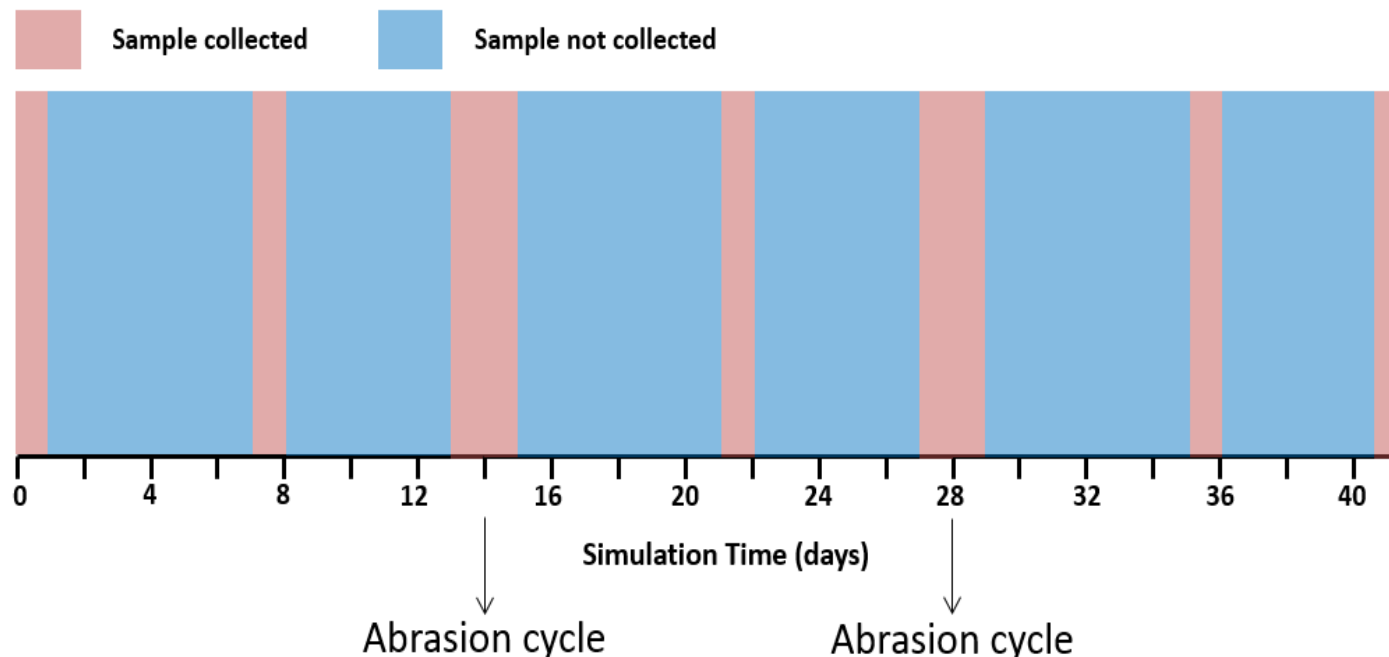
ICPMS
(Ti content
determination)

METHODOLOGY

- Controlled radiation, humidity and temperature
- Weathering parameters established according to ISO protocol (4892-2)
- Alternated dry and rain cycles



Water collection



2000 abrasion cycles
5000 N load force

METHODOLOGY

Solid residue isolation (Freeze-drying)



From:



1L of runoff waters from the climatic chamber

To:



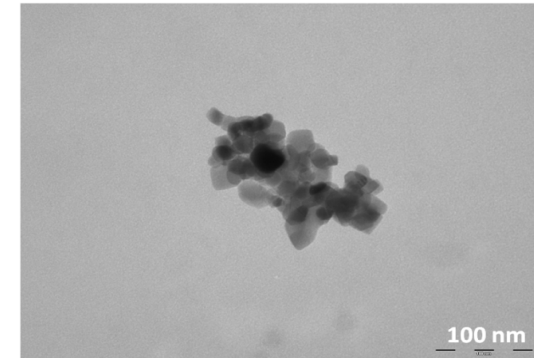
Few mg of solid residue

ICPOES
(Ti content determination)

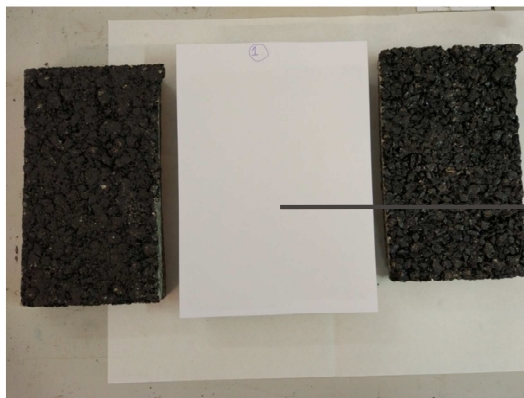
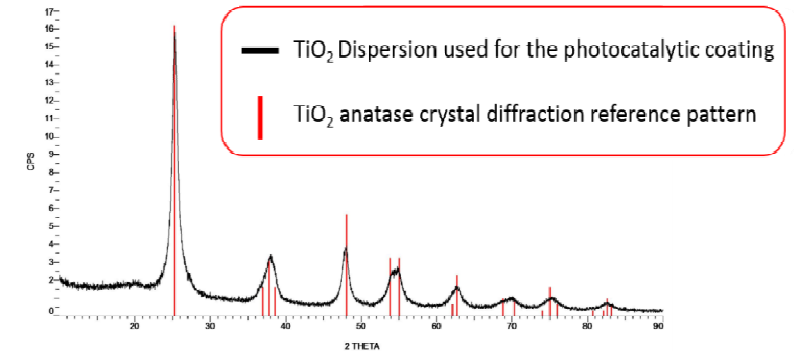
RESULTS



Electronic microscopy → SIZE
Around 25 nm; very agglomerated



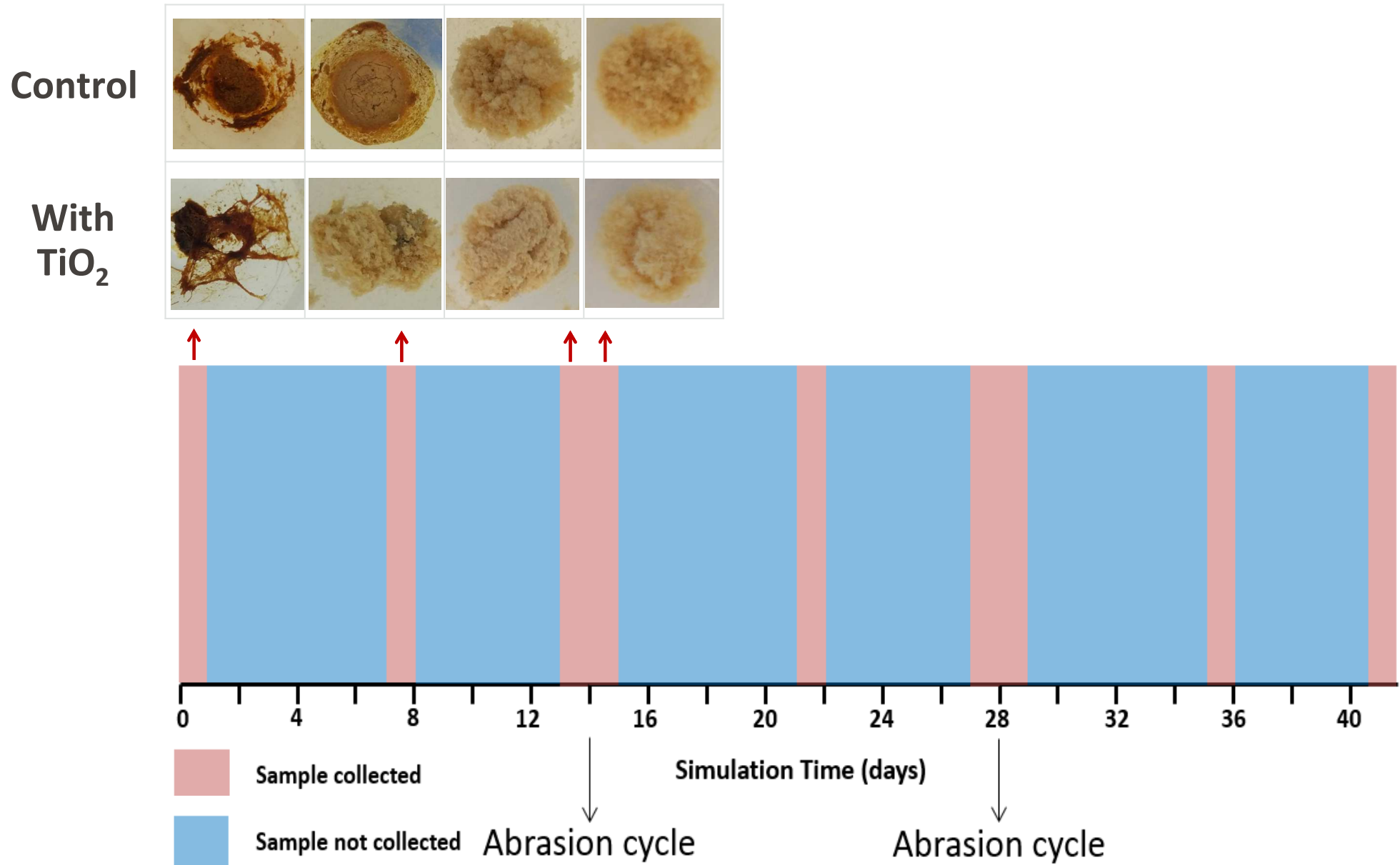
X-ray diffraction → CRYSTAL PHASE
Anatase



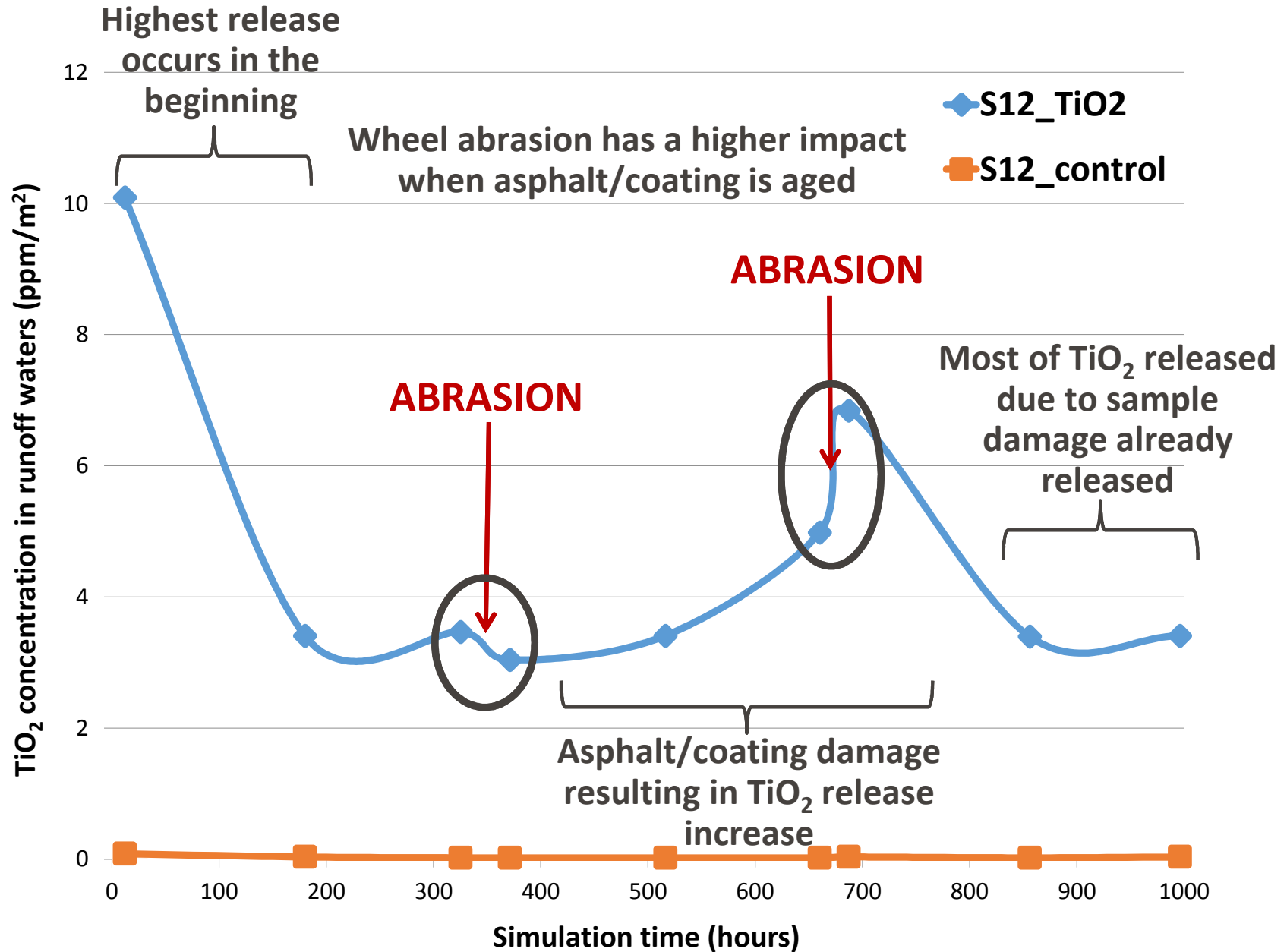
Samples	Ti concentration (g/m ²)	TiO ₂ concentration (g/m ²)
Coated Paper_A	1.6	2.6
Coated Paper_B	1.3	2.2
Coated Paper_C	1.8	3.1
Coated Paper_D	1.4	2.3
Coated Paper_E	1.6	2.6
Coated Paper_F	1.2	1.9
Average ± St. dev.	1.5 ± 0.2	2.5 ± 0.4

In the range of concentration used in real applications

RESULTS



RESULTS



RESULTS

Total amount of TiO_2 released

0.9 g/m²

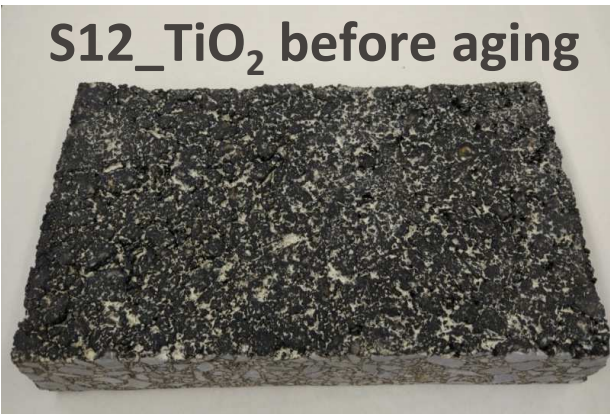
TiO_2 in the sample

2.5 g/m²

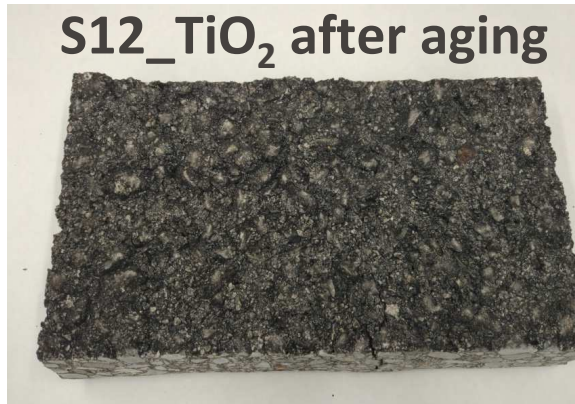
RELEASE RATE

38 %

S12_TiO₂ before aging



S12_TiO₂ after aging



S12_TiO₂

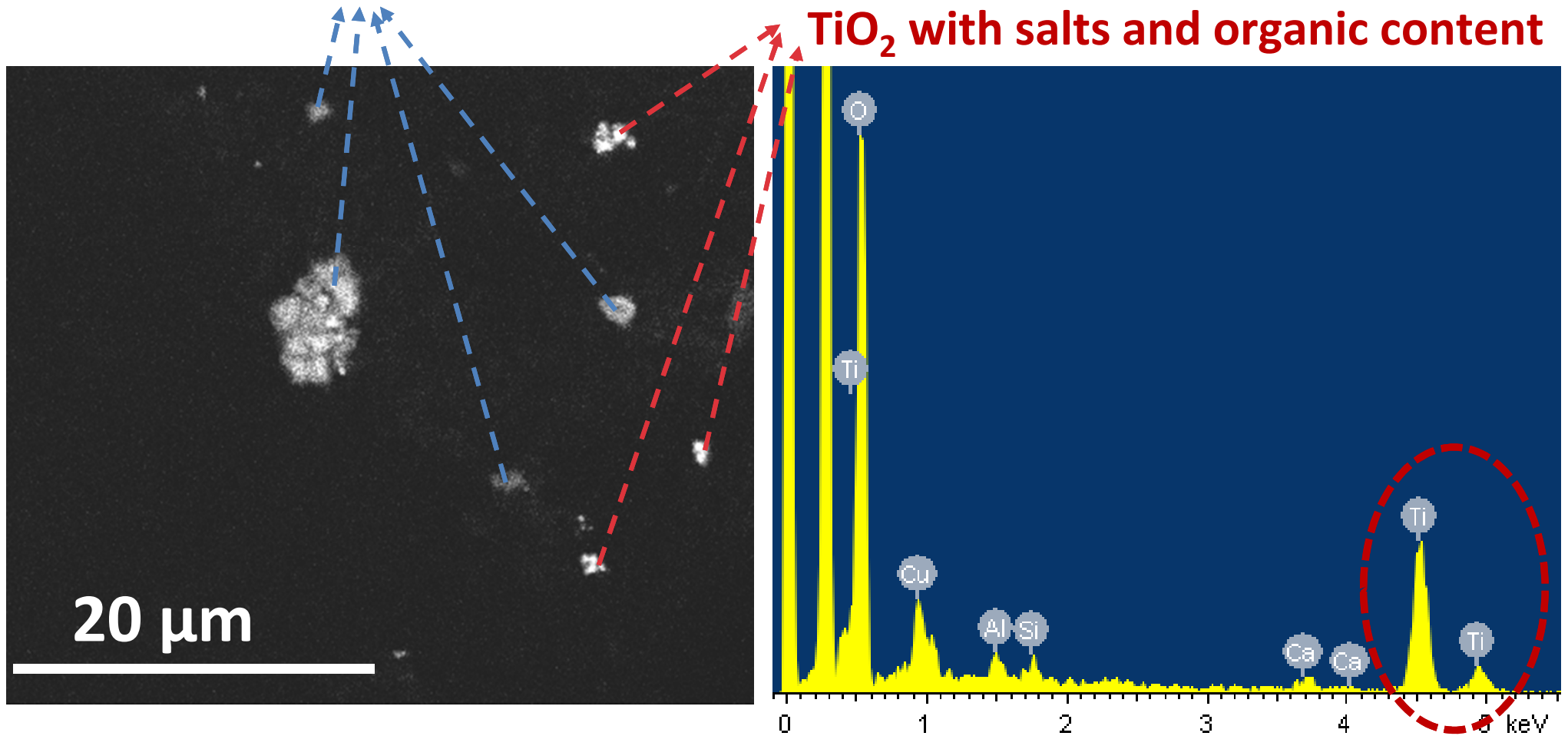
S12_control



RESULTS

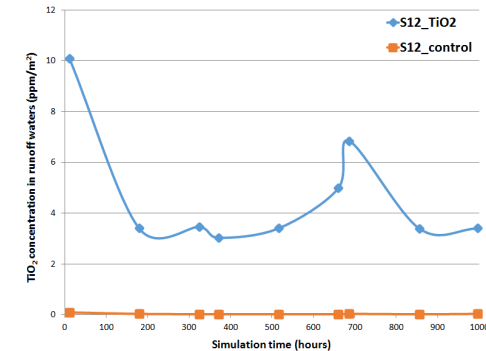
TiO₂ aggregates of few micrometers size

Salts and organic content



CONCLUSIONS

- ✓ Amount of TiO_2 released varies along time
- ✓ Higher TiO_2 release occurs in the beginning
- ✓ Wheel abrasion has a higher impact when asphalt/coating are aged
- ✓ TiO_2 was found in released waters forming few μm aggregates
- ✓ 38% of TiO_2 is released during the total duration of the experiment
- ✓ Data will be used to refine the risk assessment model build in NanoFASE



FUTURE WORK

- Perform the experiment on different asphalt compositions
- Solid residue isolation process optimization (Freeze-drying very laborious and time consuming)
- Test the photocatalytic coating effect on the asphalt mechanical performance
- Test other life cycle stages (spraying on the road)



Figure obtained from EQUINOX project

THANK YOU!

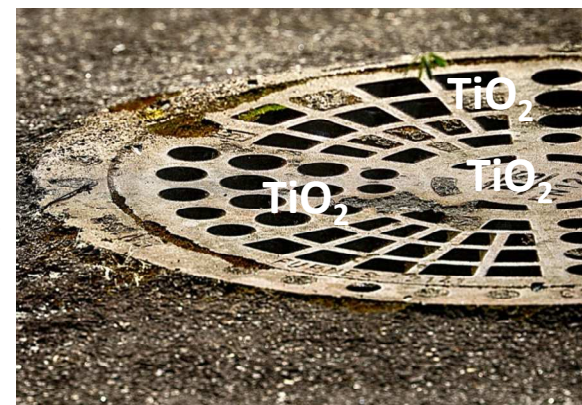
A PROBLEM



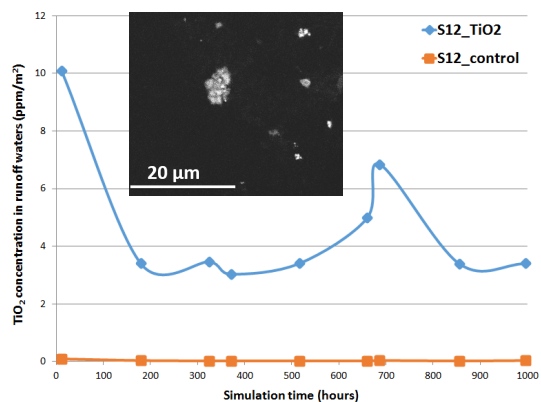
A (nano)SOLUTION



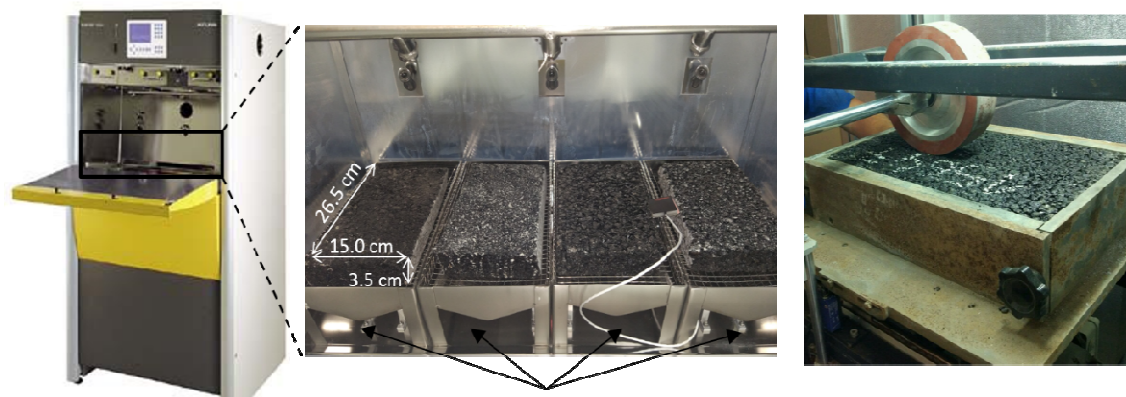
A CONCERN



A RESULT



A LIFE CYCLE SIMULATION



A CONCLUSION



THE CASE STUDY

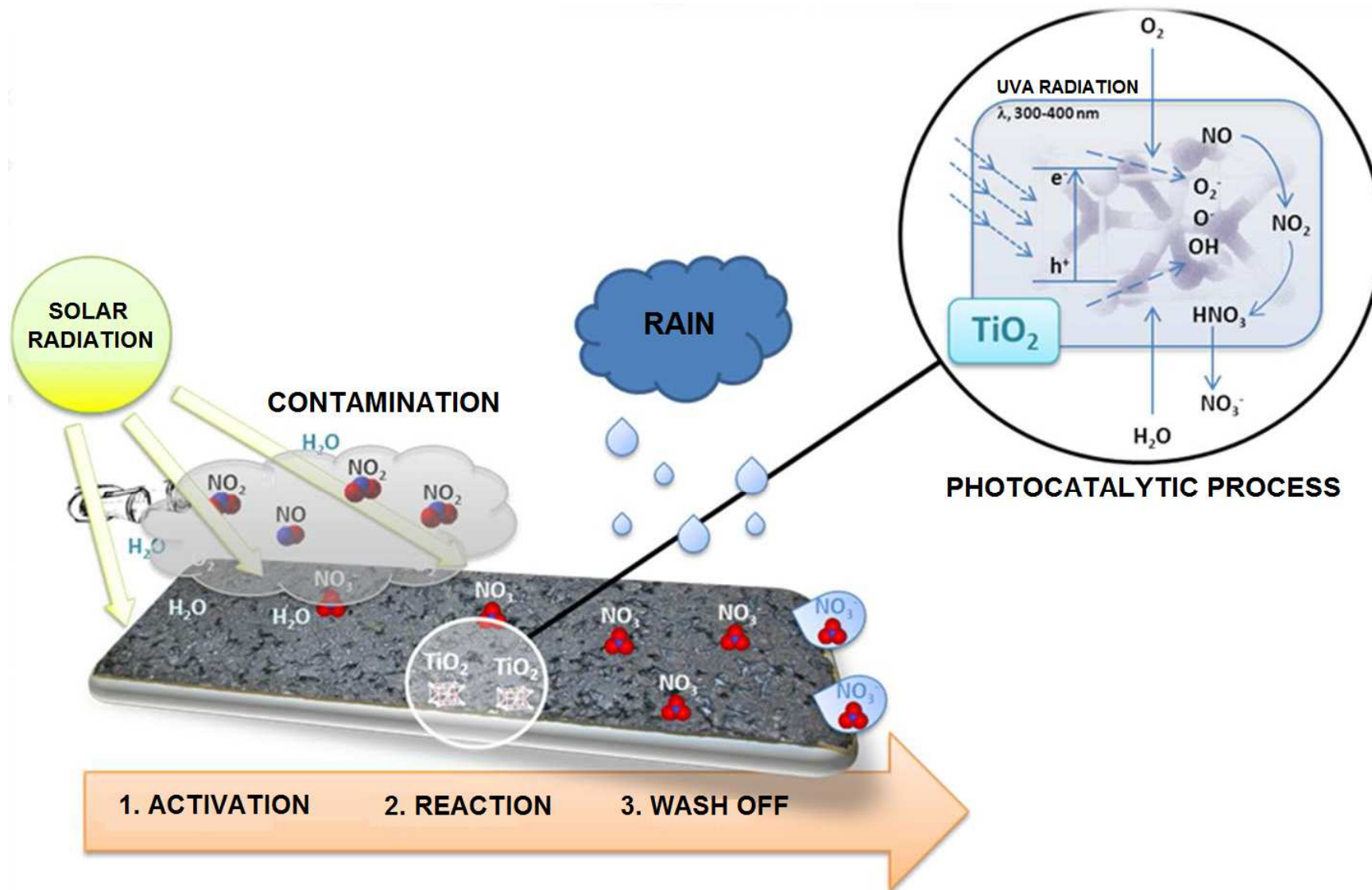


Figure adapted from EQUINOX project