Engineered nanoparticles in the marine environment – the role of microalgal extracellular polymers

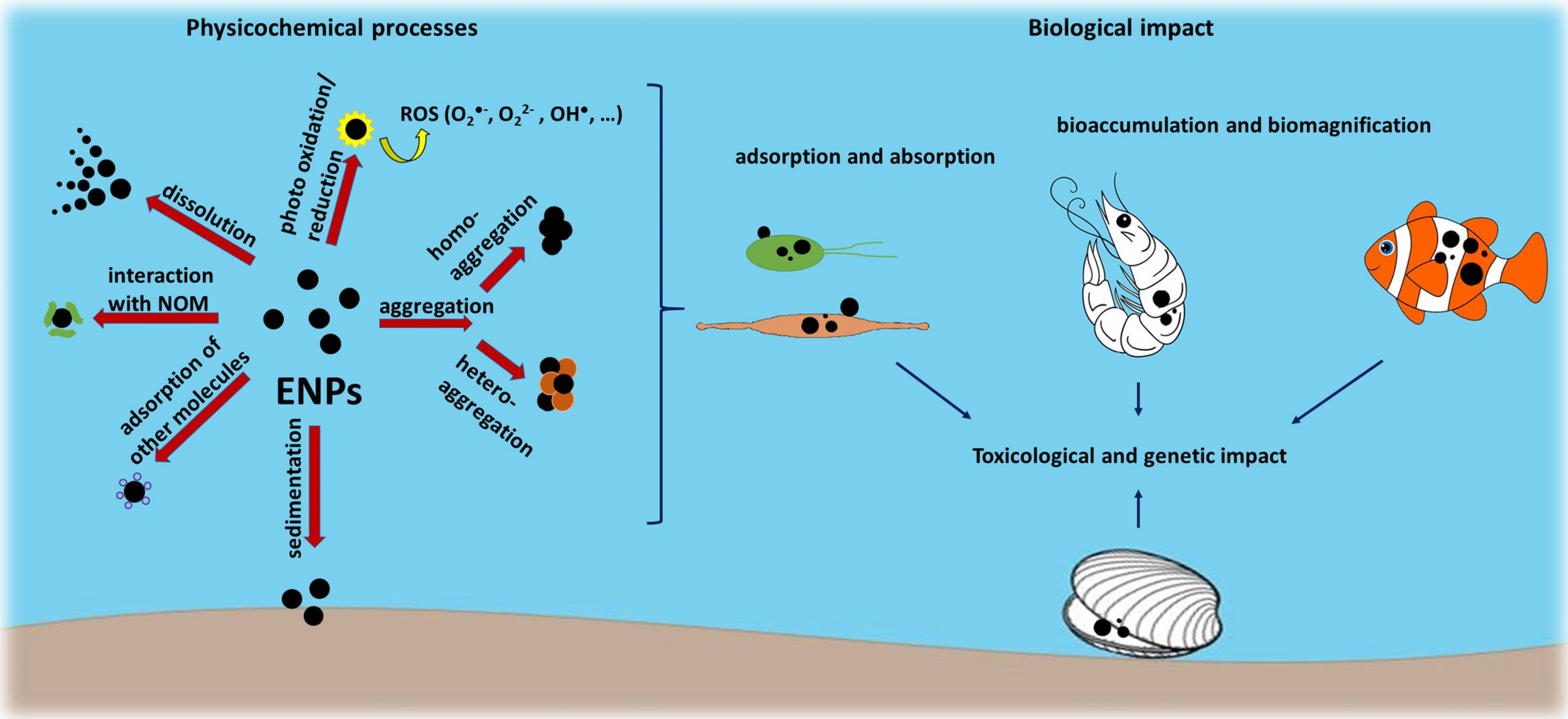
Petra Vukosav, Tea Mišić Radić
Ruđer Bošković Institute
Bijenička cestra 54, 10 000 Zagreb, Croatia
email: petra.vukosav@irb.hr

Division for Marine and Environmental Research

INTRODUCTION

Engineered nanoparticles (ENPs) constitute a major component of the global production of nanomaterials. Among them, silicon dioxide nanoparticles (SiO_2 NPs) have found extensive applications in a variety of industries (e.g. in cosmetics, drugs, toners, car tire manufacturing, etc.) [1,2]. The wide application of various ENPs causes their increasing presence in seawater.

Potential physiochemical processes and biological impacts of ENPs in seawater



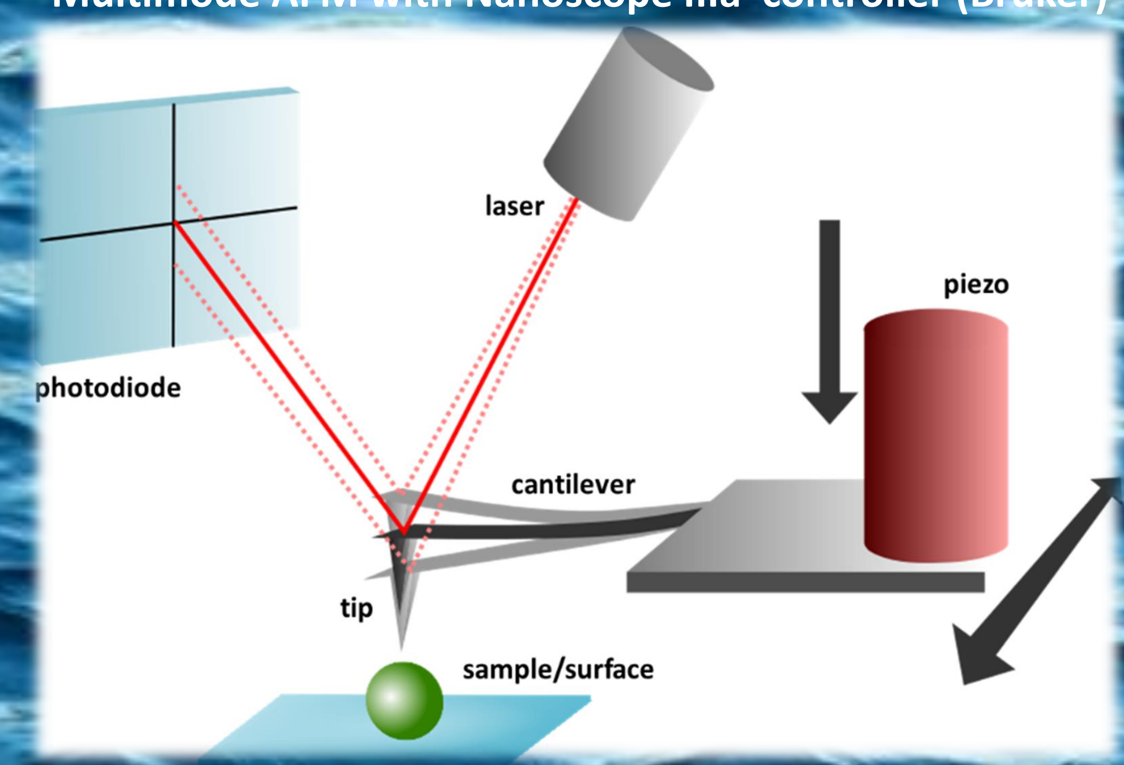
NOM = natural organic matter; ROS =reactive oxygen species

AIM

We studied the effect of microalgal EPS (extracellular organic substance), as the main component of marine natural organic matter, on the stability of silicon dioxide nanoparticles (SiO_2 NPs) in seawater.

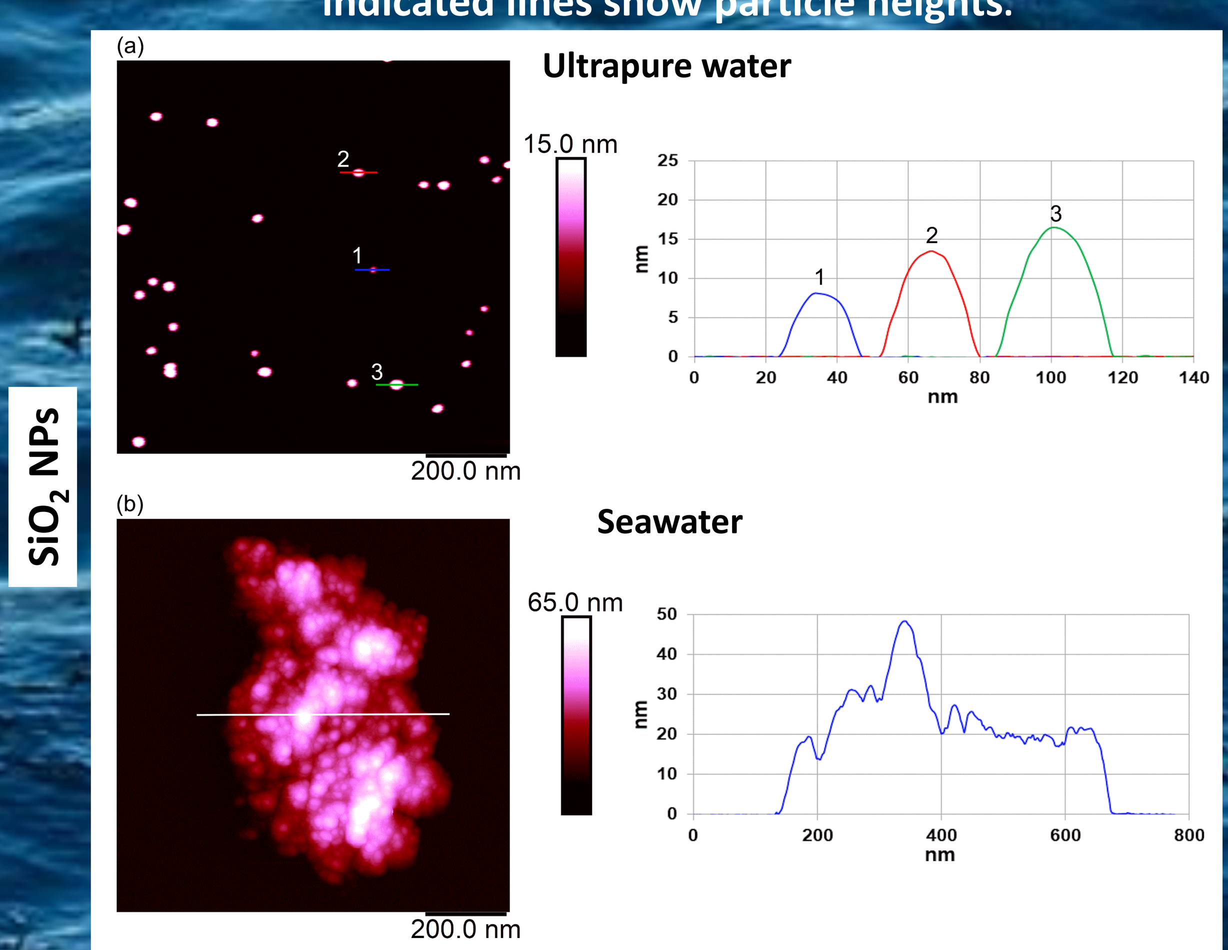
METHODOLOGY

Atomic force microscopy (AFM)
Multimode AFM with Nanoscope IIIa controller (Bruker)

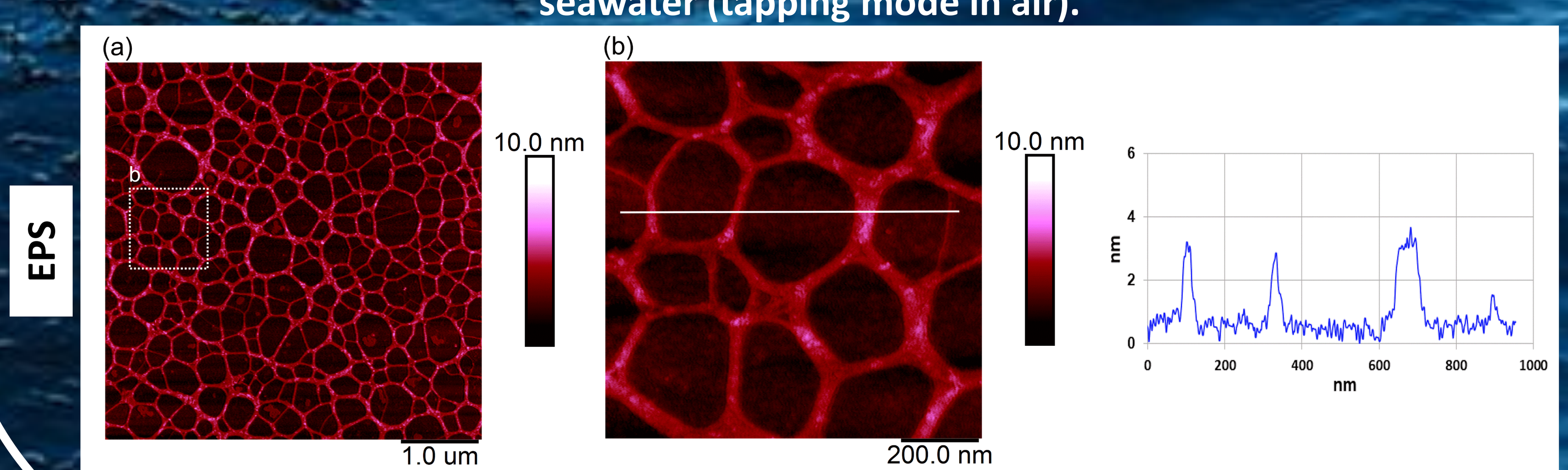


RESULTS

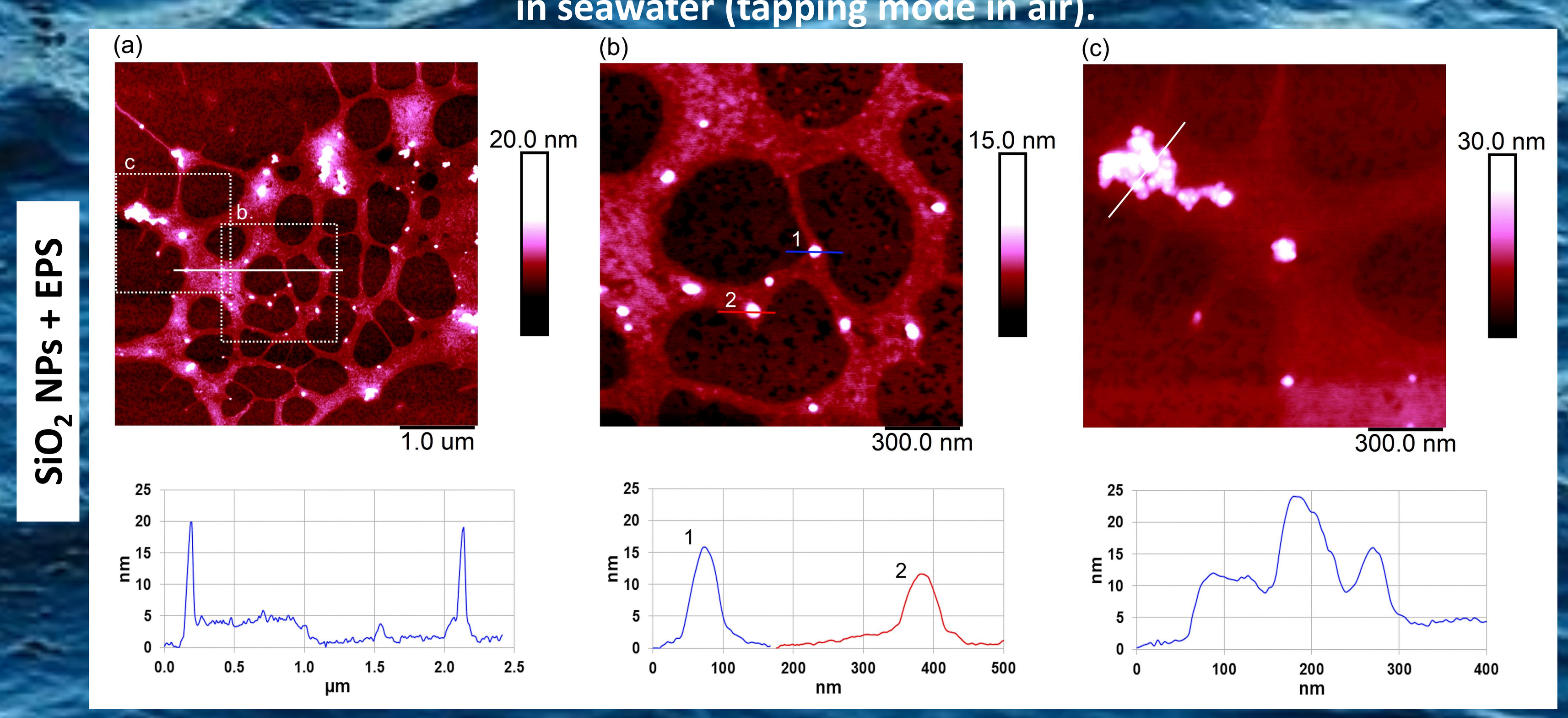
AFM images of SiO_2 NPs (10 µg mL^{-1}); tapping mode in air. Vertical profiles along indicated lines show particle heights.



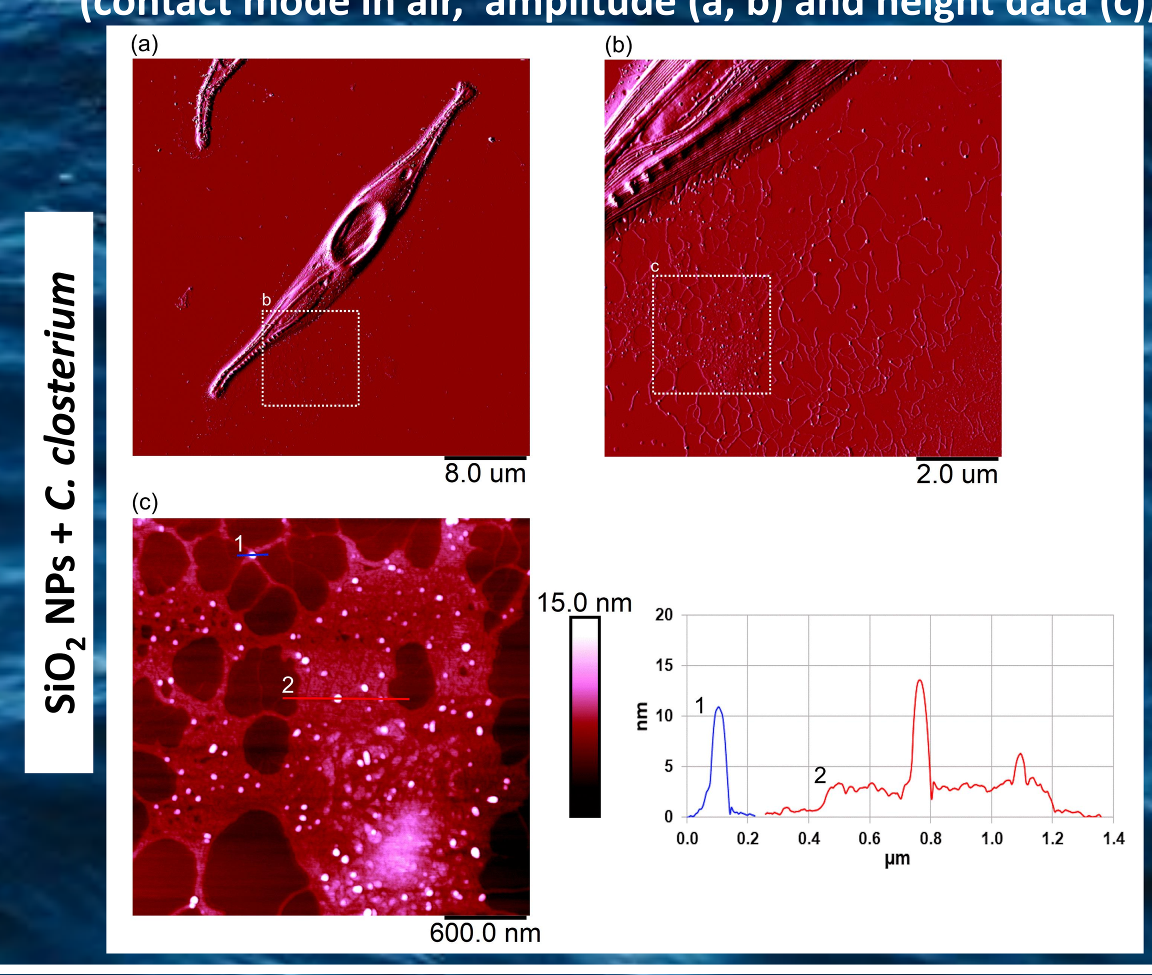
AFM images of EPS (200 µg mL^{-1}, isolated from *Cylindrotheca closterium* culture) in seawater (tapping mode in air).



AFM images of interaction of EPS (200 µg mL^{-1}) with SiO_2 (10 µg mL^{-1}) in seawater (tapping mode in air).



AFM images of *C. closterium* cell exposed to SiO_2 NPs (10 µg mL^{-1}) in seawater (contact mode in air, amplitude (a, b) and height data (c)).



CONCLUSIONS

- SiO_2 NPs are present maily as individually dispersed nanoparticles in ultrapure water, while in filtered natural seawater as microscale aggregates
- SiO_2 NPs showed strog interaction with both, isolated EPS, and at the single-cell level, with EPS released around the cell of *Cylindrotheca closterium*
- EPS has potential to scavenge and stabilize SiO_2 NPs, thus prolonging their residence time in the water column what could have significat implications, especially during microalgal blooms when EPS production increases
- our results could also explain the persistence in the water column not only of SiO_2 NPs, but most likely also of other oxide types of engineered NPs (like TiO_2, CeO_2, Ag_2O, etc.)

REFERENCES

1. Napierska, D.; Thomassen, L.C.; Lison, D.; Martens, J.A.; Hoet, P.H. The Nanosilica Hazard: Another Variable Entity. *Part. Fibre Toxicol.* 2010, *7*, 39.
2. Van Hoek, J. et al. Implications of the Use of Silica as Active Filler in Passenger Car Tire Compounds on Their Recycling Options. *Materials* 2019, *12*, 725.