Biodegradability of pristine and weathered car tire rubber using different inocula

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Car tire wear is estimated to represent a major fraction of microplastic pollution in the environment. Rubber particles are transported by wind transport and road runoff, thereby reaching soils and wastewater treatment systems. Information on their occurrence, fate and degradability in environmental and engineered systems is limited yet crucial to determine their persistence and potential risks associated to their exposure.

In this study, we assessed the biodegradability of car tire rubber (90-125 μm) under controlled laboratory-scale conditions. Standardized batch tests (OECD 301 and ISO 14851) were used to determine complete mineralization under aerobic conditions of pristine and UV-weathered tire rubber in the presence of three different microbial inocula, i.e. activated sludge, soil particles and soil supernatant. Acetate and poly(D,L-lactide-co-glycolide) (PLGA) were used as positive controls in terms of readily degradable substrate and degradable plastic material, respectively.

Pristine and weathered rubber exhibited low but measurable biodegradation levels in the presence of activated sludge (3.8-7.6% ThOD) and soil supernatant (0.8%-2.3%), while no degradation was observed when using soil particles as inoculum. Accelerated UV weathering and higher biomass concentration was found to increase the biodegradability by activated sludge. Interestingly, increased response in terms of oxygen consumption was observed with acetate as co-substrate, indicating improved rubber degradability in the presence of a readily degradable carbon source. PLGA exhibited limited biodegradability (<17.4%). Scanning electron microscopy analysis revealed increased porosity and roughness on rubber surfaces over the course of the experiments, seemingly indicating degradation via surface colonization.
Overall, ready biodegradability tests proved suitable to obtain information on degradation of car tire rubber. This study provides first evidence of their degradability, especially for weathered rubber in the presence of a co-substrate, which should be considered for future studies and fate assessment. No inhibitory effect of rubber on microbial activity was observed. PLGA as positive control in short-term tests is not encouraged due to its limited biodegradability. Future work should consider longer test durations, which may be necessary to provide sufficient biofilm colonization of rubber particles, and assess other (abiotic) degradation mechanisms.

Keywords: Biodegradation, microplastics, tire rubber, PLGA, co-metabolism, biofilm

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