Simulated leaching and photodegradation of tire tread particle-derived compounds in natural water

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Tire wear particles (TWP)

- Microplastics found in stormwater and roadway runoff leads to surface water pollution.

**Tires and road surface interaction**

- Shear force
- Evaporation of volatile content
- Release of coarser particles (PM10)
- Release of finer particles (PM2.5, PM 0.1)

Pristine, cryomilled tire tread particles
32.2 um ± 25.5 um

Kim & Lee, 2018; Wagner et al., 2018
TWP-derived compounds

- Leachate resulted in coho salmon death (McIntyre et al., 2021)
- **6PPD-Quinone** associated with mortality

McIntyre et al., 2021

NOAA
TWP-derived compounds

- Which chemicals leach from TWP?
- How rapidly do chemicals leach under sunlight? What is their persistence?

Oregon Department of Forestry

TWP suspended in water
**Methods**

❖ **TOC Analysis**
- Dissolved organic carbon (DOC) and total dissolved nitrogen (TDN)

❖ **Experimental Setup**
- TWP
- Lab-created freshwater (low DOC)
- Sunlight or dark conditions

❖ **Fluorescence spectroscopy**
- Many trace organics are fluorescent
- Technique: 4 mL sample in cuvette; non-destructive

Three-dimensional excitation emission matrices (3D EEMs) of different water types (Wasswa et al., 2019)

Jablonski diagram
Leaching TWP under photoirradiation

- 470 W/m²
- Samples (10 g/L) and controls inside the Solar Simulator

- Laboratory-created freshwater only
- Pristine or aged TTP
- Laboratory-created freshwater only
- Pristine or aged TTP
TWP-specific compounds

- **Cyclohexanamines** = used in rubber manufacturing
- **Quinolines** = nitrogenous heterocyclic aromatic compounds

Cyclohexanamine, N-cyclohexyl-

Quinoline, 1,2-dihydro-2,2,4,-trimethyl-

Peaks 3 and 5

Peak 4
Step 1
Leach TWP in laboratory-made freshwater (low DOC) for 1 and 6 days in dark conditions

Step 2
Filter TWP suspensions to remove particles

Step 3
Combine leachates (dissolved compounds in water) without particles

Step 4
Track degradation of compounds using fluorescence spectroscopy

Solar Simulator
TWP leachate photodegradation

0 hours

3 days

Fastest degradation

Pristine TWP leachates
TWP leachate photodegradation

0 hours

3 days

Pristine TWP leachates

Slowest degradation
Conclusions

- In under 24 hours, most compounds leach from TWP in water
- Compounds can be photo-labile, persistent, or volatile
- TWP-specific compounds can be tracked with fluorescence
- Next steps: identify additional compounds that were rapidly degraded or persisted under sunlight
Thank You

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