# Formation and Morphological Appearance of Tyre Wear Particle Emissions

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### **1. Introduction**

- Increase in PM10 & PM2.5 tyre wear emissions
- Tyre wear emissions are a major contributor to urban air pollution

PM2.5	PM10
30	40
25	35

# 2. Experiment

- Analysing tyre wear emissions during chassis dynamometer tests
- Tests on a passenger car (BMW i3) with enclosed tyre and brake

Measurement Setup on the BMW i3 Test Vehicle

**Measurement Equipment** 

Particle Diameter [un

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Course of exhaust and non-exhaust emissions from road traffic in the UK.<sup>[1]</sup> © Crown 2023 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

**Objective:** Gain insight into the formation of tyre wear particles in order to identify approaches for its reduction

# **3. Results**

#### **Particle Measurements**

- Highest particle emissions during acceleration
- Higher velocities result in higher emissions
- Particle modes at 10 and 200 nm (DMS 500), 400 nm (OPS)





#### **SEM/EDS Analyses**

- Different particle sizes collected on 14 ELPI stages
- Morphological features revealed on secondary electron images
- Larger particles (ELPI stage 9):
- Several µm in size  $\rightarrow$
- Platelets or rod-like shapes  $\rightarrow$
- Mechanical formation of particles  $\rightarrow$
- Smaller particles (ELPI stage 6):
- Several hundred nm in size  $\rightarrow$
- More rounded shapes  $\rightarrow$
- Formation from gas phase  $\rightarrow$





- EDS-spectra on coated (Au) polycarbonate substrates
- C, O, Si, S can be assigned to tyre tread (see table)
- Other elements from pavement/previous vehicle tests
- No major difference in composition

Pure tyre	Mass %
С	72.5
Ο	22.1
Si	4.6
Zn	0.5
S	0.3

# 4. Summary & Conclusions

- Measurement of tyre wear emissions on a chassis dynamometer
- Testing different driving scenarios with a passenger car showed that the particle number concentration depends on speed and acceleration
- Size-selective particle collection with ELPI was used to study morphology and chemical composition on SEM
- Larger particles are platelets/rods, indicating mechanical formation
- Smaller particles have rounded spherical shapes, indicating particle condensation from the gas phase
- Adjustment of chemical composition could reduce UFP emissions  $\rightarrow$
- Besides C and O, there are many other elements from different sources

#### Acknowledgments

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[1] Lewis, A., Moller, S.J., Carslaw, D., 2019. Non-exhaust Emissions From Road Traffic. Research Report, Defra, United Kingdom.

