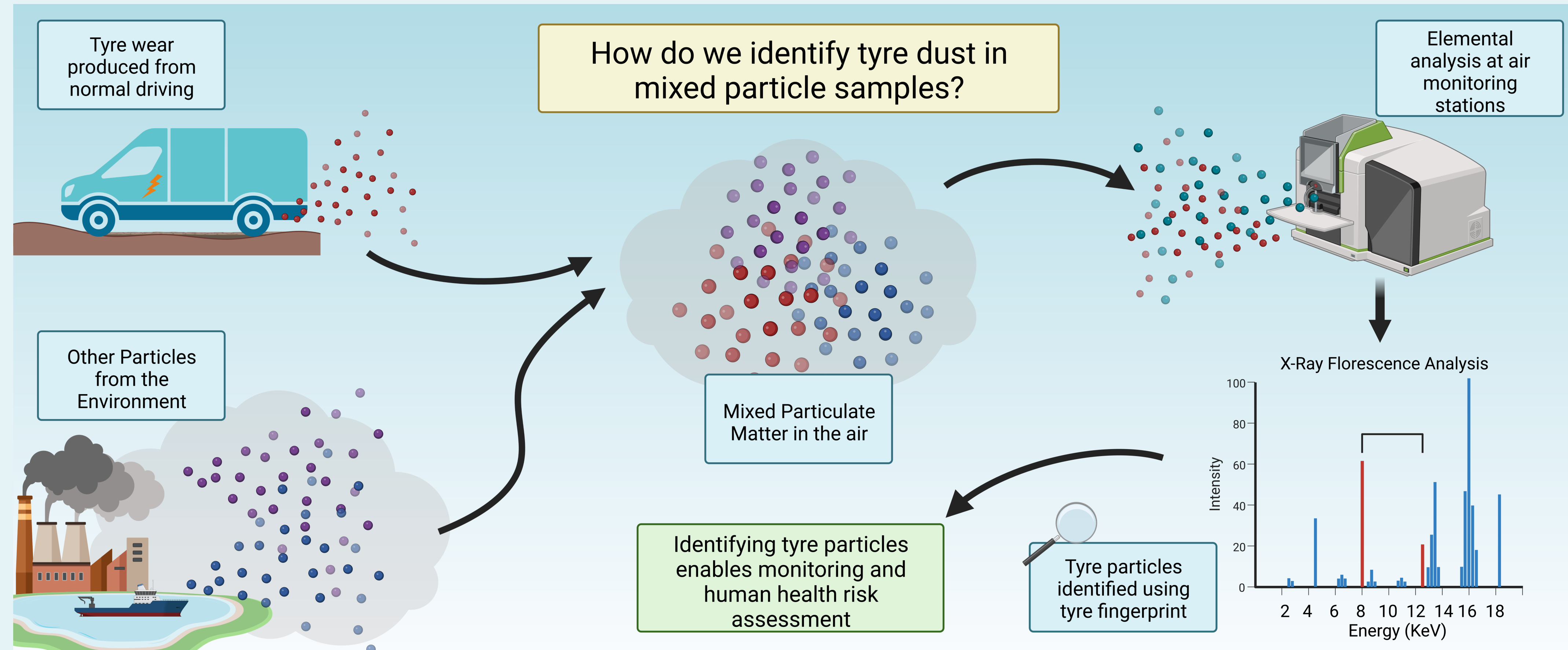


Physicochemical Characterisation and Potential Health Effects of Non-Exhaust Particle Emissions

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Health Context

The potential health effects of non-exhaust particles are **poorly understood** with experiments ongoing. Metals in tyre rubber have been found to leach into watercourses and have **significant adverse outcomes** in fish, with aquatic toxicity of scrap tyres being identified in the 1990's. Brake wear particles have been shown to exacerbate lung inflammation and compromise phagocytosis in macrophages. Identifying and quantifying non-exhaust PM in the atmosphere is a complex challenge due to their chemically complex makeup and non-homogenous composition.

Tyre Metal Analysis

Car Tyre Analysis

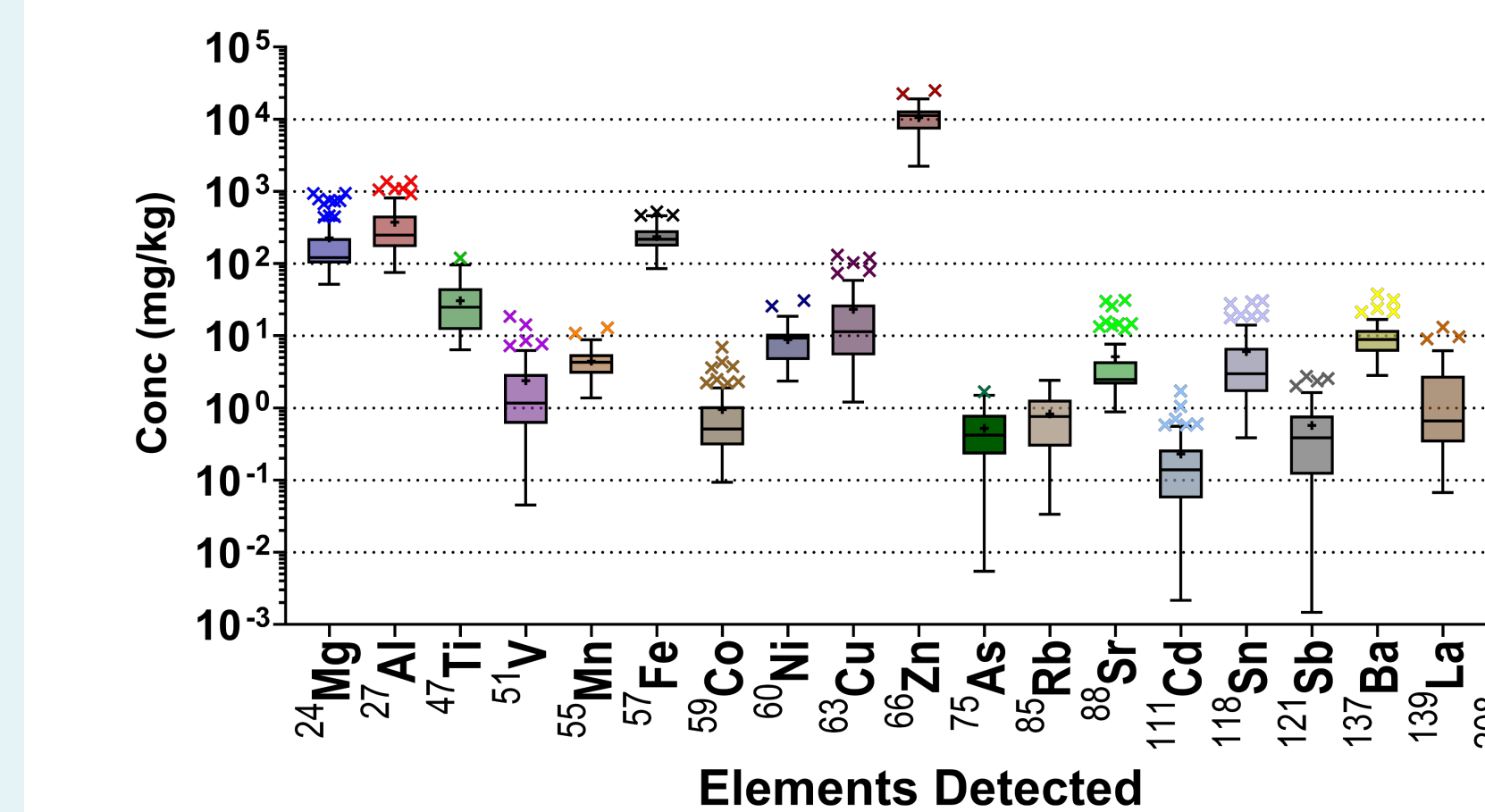


Figure 2. 76 tyre rubber samples were analysed by ICP-MS for trace metals to identify a **representative tyre fingerprint**.

To develop a **unique tyre fingerprint** that can be used to identify tyre rubber in the atmosphere, we analysed 76 tyres by ICP-MS.

This fingerprint has been published and accepted for inclusion in **SPECIEUROPE**, the EU JRC's source apportionment database.

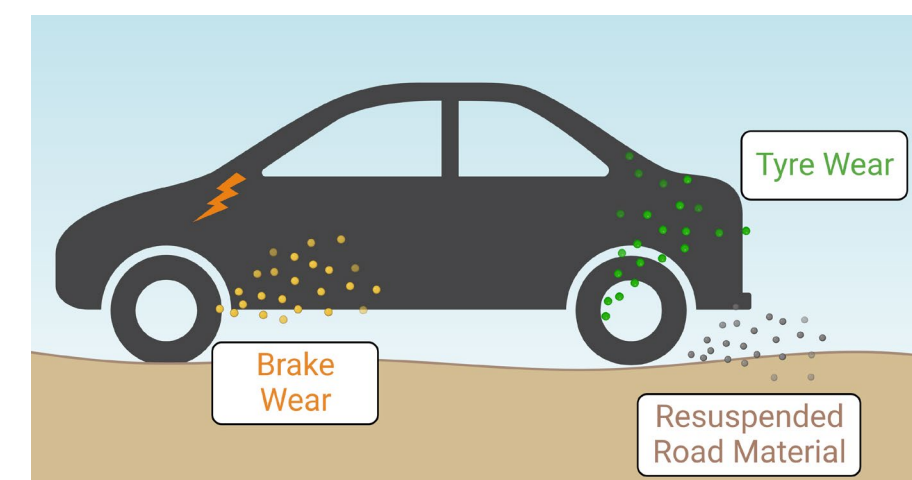


Introduction

Until now, research into the health effects of particulate emissions from vehicles has mainly focused on **exhaust** (tailpipe) emissions. However, non-exhaust particulate emissions due to **brake, tyre, and road wear** are produced by electric and combustion-engine vehicles and contribute significantly to airborne particles from road traffic.

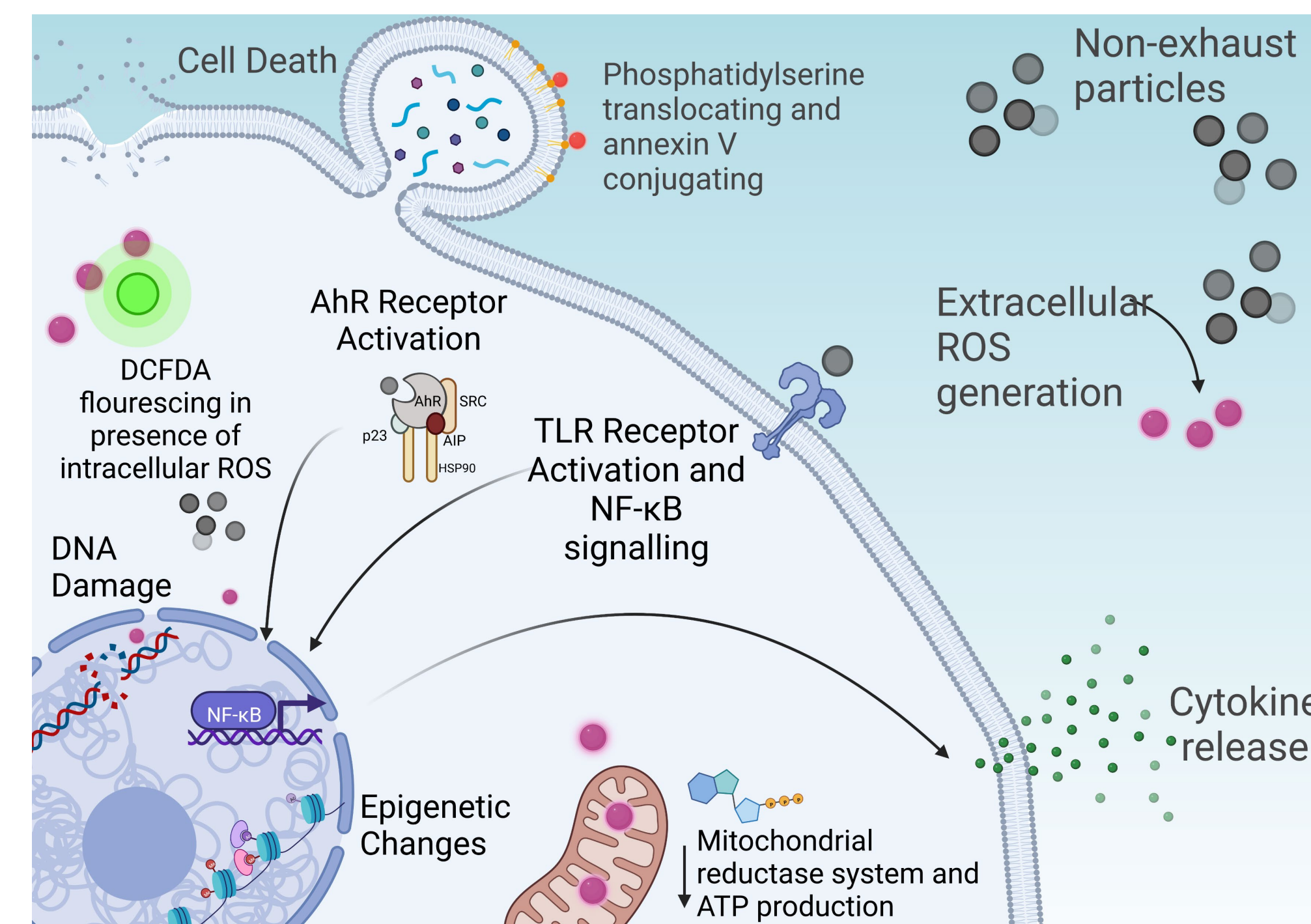
Brake wear is the most prevalent constituent of roadside PM, accounting for around 55% by mass. Resuspended material represents 38%, and tyre wear makes up around 11%. Data submitted by the UK Government to the United Nations Convention on Long-range Transboundary Air Pollution forecasts that non-exhaust emissions are expected to rise to

9 kilotonnes by 2030, while exhaust emissions continue to fall



Objective

To gain a simultaneous understanding of the **composition**, size, and morphology of non-exhaust PM, and an insight into their potential adverse **human health effects**.



Project Toxicology Endpoints – Graphical Summary

Particle Imaging

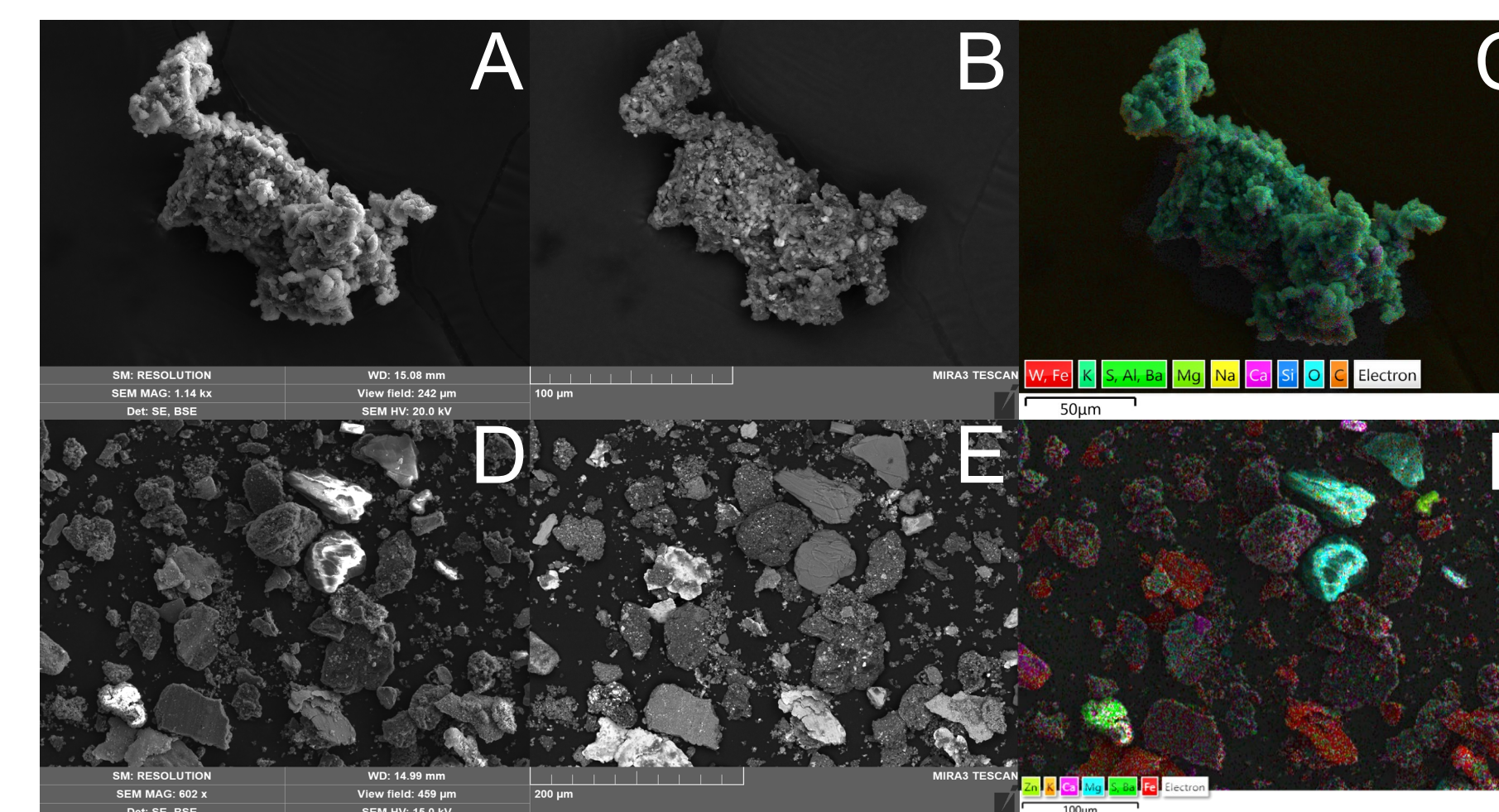


Figure 1. A-C Electron Micrographs and Elemental analysis overlay of a tyre wear particle

Figure 1. D-F Electron Micrographs and Elemental analysis overlay of a brake abrasion dusts.

SEM-EDS Analysis of non-exhaust particles allows us to gain an understanding into the size, shape and chemical composition of brake and tyre wear. We see that **tyre wear particles are chemically uniform**, and may contain road particles, while **brake particles can be enriched** with one metal or component such as Iron or Barium Sulphate

Biological Importance

Brake wear (BAD) reduces mitochondrial reductase activity to a **greater extent than diesel exhaust particles**. Using the cytotoxicity and mitochondrial function assay WST-1, increasing doses of either BAD or diesel exhaust particles (DEP) were assessed in human bronchial epithelial cells

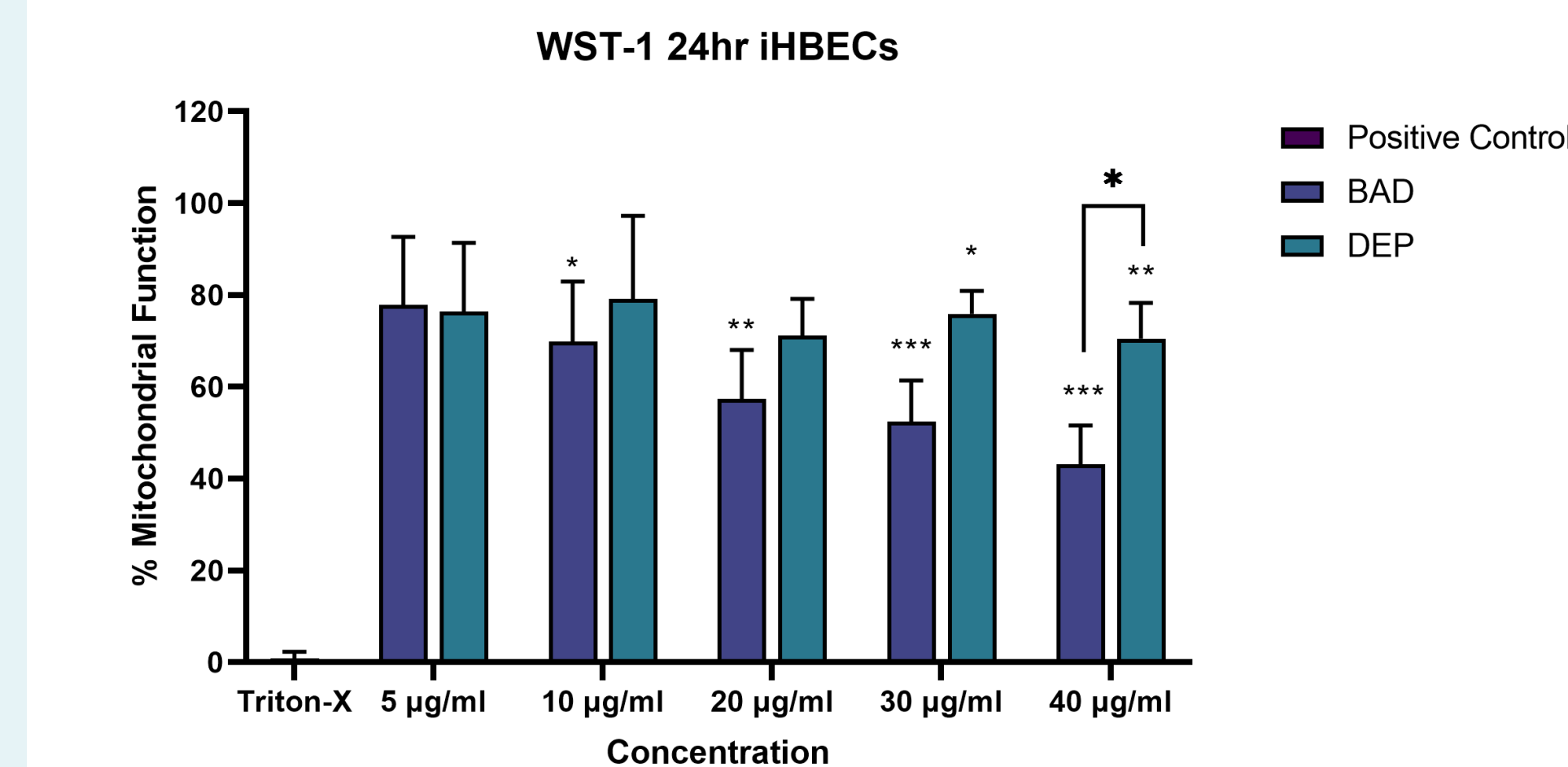


Figure 3. WST-1 analysis of BAD and DEP for 24hr in iHBECS

Discussion

- The primary particles of tyre particles are an aggregate of rubber and metals, while brake wear are made up of single element species (Fig. 1)
- Tyre rubber contains a unique and diverse metallic composition that can be used for fingerprinting (Fig. 2)
- Brake wear particles can reduce mitochondrial function in a dose dependent manner to a greater extent than diesel particles (Fig.3)

Acknowledgements

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