

Supplementary materials

Supplementary Table S1. Chemical characterization of tyre and road wear particles, transformation products and suitability as marker

N o.	Component	Parent compound	Degradation products	Identified in environmental samples	References	Comments
1	Aliphatic compounds and aromatic compounds			phenanthrene (Phe), anthracene (Anth), fluoranthene (Fluo), pyrene (Pyr), benzo[b]fluoranthene (BbF), benzo[k]fluoranthene (BkF), benzo[a]pyrene (BaP), and benzo[ghi]perylene (BghiP)	Alves et al. (2020)	Due to the widespread use of these compounds in automobile fuel, not recommended a suitable indicator of TRWPs.
2	Rubber	Styrene butadiene rubber (SBR), Butadiene rubber (BR)	4-vinylcyclohexene (4-VCH)- pyrolysis product), Dipentene (DP)	SBR, BR, 4-VCH	More et al. (2023); Miller et al. (2022);	Widespread use of rubber does not fit in well as marker.
3	Elemental substances	Zinc (Zn), Cobalt (Co), lithium (Li), titanium (Ti), chromium (Cr) and neodymium (Nd), Barium (Ba)		Zinc (Zn), Cobalt (Co), lithium (Li), titanium (Ti), chromium (Cr) and neodymium (Nd), Barium (Ba)	Unice et al., 2013; Beddows et al., 2023; Beji et al., 2023; O'Loughlin et al., 2023; Müller et al., 2022; Rausch et al., 2022; Choi et al., 2020; Kovochich et al., 2021; Alves et al., 2020; Klöckner et al., 2019; Adachi and	Zn, being a significant component (~1%) in the formulation of tyres, could be used for the validation of TRWPs, when objective of the study is to report the concentration of TRWPs in terms of numbers. Taking into

					Tainosho, 2004	consideration the major contribution of other elemental components, they are not considered ideal for the assessment of TRWPs.
4	Antioxidants	N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD)	1,3-dimethylbutylamine(1,3-DMBA), 4-hydroxydiphenylamine (4-HDPA), <1% 4-aminodiphenylamine(4-ADPA), 4-nitrosodiphenylamine (4s DPA) and 4-nitrodiphenylamine(4-NDPA)	- N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD) - N-(1,3-Dimethylbutyl)-N'-phenyl-p-phenylenediamine (6-PPD-Q) , 1,3-dimethylbutylamine (1,3-DMBA), (4s DPA) and 4-aminodiphenylamine(4-ADPA), - N,N'-diphenyl-p-phenylenediamine (DPPD), - N-Isopropyl-N'-phenyl-p-phenylenediamine (IPPD)	Zhao et al., 2023; Deng et al., 2022; Hiki and Yamamoto, 2022	Targeted compounds are analysed in the literature, suggesting thorough analysis without targeting specific compound. However, presence of 6PPD, 6PPD-Q and 1,3-DMBA in the leachate of TRWPs indicates towards possibility of using these compounds as marker for TRWPs.
		2,2,4-trimethyl-1,2-dihydroquinoline) (TMQ)	Existing literature shows underrepresentation of TMQ, suggesting further investigation to understand the behaviour of TMQ in the environment.			
5	Vulcanising accelerators	- N-cyclohexyl-2-benzothiazolesulfenamide (CBS), - Diphenylguanidine (DPG)	- Mercaptobenzothiazole (MBT), - Benzothiazole-2-sulfonate (BTSA), - aniline, 2-(methylthio)benzothiazole (MTBT), - Aminobenzothiazole ($NH_2 - BT$),	- Benzothiazole (BTH), 2-hydroxybenzothiazole (2-OH-BTH), 2-chlorobenzothiazole (2-Cl-BTH), 2-Methylthio-benzothiazole (2-Me-S-BTH), 2-Molybdo-benzothiazole (2-Mo-BTH)	Weyrauch et al., 2023; Peter et al., 2018; Deng et al., (2022); Müller et al., 2022a; Zhang et al., 2018	Extensive use of benzothiazole and its transformation products in industry, pesticides, hospitals and agriculture sector does not make vulcanizing

			• Benzothiazole carboxylic acid (BTCA), • Dicyclohexylamine(DCA), Hydroxybenzothiazole (OH-BT), • 1,3-dicyclohexylurea, • 1-cyclohexyl-3-phenylurea, • N-methyl-dicyclohexylamine, • Tributylamine, • Dibenzylamine and • <i>N,N'</i>-Diphenylurea			accelerator a suitable marker.
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