Supporting Information

Insight into the size-resolved markers and eco-health significance of microplastics from typical sources in northwest China

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Table S1 List of pyrolyzed products and selection of quantified markers for MPs analysis.

Polymer	Pyrolysis Product	Potential Qualification Marker
PE	C20 alkane	C20 alkane
	C20 α-alkane	C20 α-alkane
	C20 α,ω-alkane	C20 α,ω-alkane
PP	2,4-dimethylhept-1-ene	2,4-dimethylhept-1-ene
	2,4,6,8-tetramethyl-1-undecene	2,4,6,8-tetramethyl-1-undecene
PS	3-butene-1,3-diydibenzene	3-butene-1,3-diydibenzene
	5-hexane-1,3,5-trytribenzene	5-hexane-1,3,5-trytribenzene
PVC	1-chloroindan	1-chloroindan
	dihydronaphthaleneazelene	dihydronaphthaleneazelene
NR	1-methyl-4-(1-methylethenyl)-cyclohexane dipentene	1-methyl-4-(1-methylethenyl)-cyclohexane dipentene
BR	4-vinylcyclohexene (dimer)	4-vinylcyclohexane*
SBR	4-vinylcyclohexene	4-vinylcyclohexane*

*4-vinylcyclohexane is selected for the marker, and only a sum of BR and SBR are reported.

Table S2 Concentrations (ng/m^3) of MPs and plasticizers in $PM_{2.5}$ and PM_{coarse} from five sources.

	$PM_{2.5}$					PM_{coarse}				
	PB	**FB**	**RT**	**AF**	**LB**	**PB**	**FB**	**RT**	**AF**	**LB**
PE	445 ± 238	188.0 ± 27.6	4.77 ± 1.68	22.1 ± 3.62	40.7 ± 22.6	242 ± 12.7	304 ± 56.0	4.47 ± 1.41	13.6 ± 26.2	25.3 ± 16.9
PP	164 ± 35.2	74.3 ± 8.04	1.84 ± 0.70	15.7 ± 3.67	14.9 ± 6.26	192.9 ± 40.3	84.8 ± 20.8	1.26 ± 0.25	6.47 ± 16.8	16.9 ± 9.85
PS	64.5 ± 18.5	31.1 ± 2.82	0.66 ± 0.23	43.7 ± 10.1	3.81 ± 1.70	75.9 ± 7.07	33.5 ± 6.46	0.52 ± 0.12	18.3 ± 53.3	4.03 ± 1.71
PET	922 ± 389	452 ± 48.7	6.20 ± 2.24	34.1 ± 4.81	71.1 ± 35.0	421 ± 16.7	669 ± 138	4.77 ± 2.06	24.4 ± 41.0	71.3 ± 36.1
PMMA	305 ± 95.3	67.9 ± 4.17	2.11 ± 0.83	3.18 ± 0.73	8.62 ± 4.09	698 ± 24.7	81.8 ± 16.5	1.43 ± 0.515	4.49 ± 1.48	8.58 ± 4.56
PVC	3.27 ± 1.33	1.52 ± 0.16	0.33 ± 0.14	0.09 ± 0.02	bd	2.17 ± 0.48	2.21 ± 0.17	0.26 ± 0.08	0.05 ± 0.09	bd
NR	0.92 ± 0.06	bd	25.9 ± 10.5	0.05 ± 0.06	0.21 ± 0.11	1.48 ± 0.10	bd	7.71 ± 2.48	0.04 ± 0.06	0.23 ± 0.13
BR+SBR	1.15 ± 0.02	bd	35.9 ± 9.02	0.07 ± 0.02	0.65 ± 0.32	1.05 ± 0.14	bd	21.0 ± 4.75	0.05 ± 0.09	0.4 ± 0.19
MPs	**1906 ± 586**	**815 ± 90.6**	**77.7 ± 25.3**	**119 ± 23**	**140 ± 70.1**	**1634 ± 20.3**	**1175 ± 238**	**41.5 ± 11.7**	**67.4 ± 136**	**127 ± 69.4**
DMP	670 ± 370	107 ± 10.9	6.76 ± 2.55	38.1 ± 10.8	66.0 ± 28.1	1412 ± 75.3	87.4 ± 19.2	2.70 ± 1.04	14.8 ± 30.3	32.7 ± 30.6

DEP	1834 ± 1216	264 ± 39.5	3.19 ± 1.27	31.4 ± 5.95	113 ± 61.3	3405 ± 161	110 ± 68.0	1.28 ± 0.72	26.9 ± 15.4	31.5 ± 50.0
DBP	1205 ± 617	305 ± 10.9	28.5 ± 10.6	65.8 ± 3.59	291 ± 144	1759 ± 426	131 ± 60.6	8.96 ± 3.30	23.3 ± 57.0	117 ± 95.2
BBP	3926 ± 1796	1058 ± 84.9	47.0 ± 16.6	102 ± 9.40	597 ± 288	4989 ± 592	396 ± 208	16.6 ± 8.28	69.9 ± 81.2	460 ± 238
DEHP	3199 ± 911	1161 ± 81.8	106 ± 37.0	66.8 ± 9.17	413 ± 175	2522 ± 295	630 ± 293	34.8 ± 16.6	32.8 ± 49.4	324 ± 184
DNOP	4806 ± 825	1637 ± 215	277 ± 107	201 ± 27.7	688 ± 358	8189 ± 281	1398 ± 2.20	51.0 ± 24.5	116 ± 169	191 ± 282
PAEs	**15640 ± 5609**	**4532 ± 393**	**468 ± 175**	**505 ± 66.5**	**2168 ± 1052**	**22275 ± 1680**	**2753 ± 646**	**115. ± 54.4**	**284 ± 401**	**1157 ± 880**
BT	10.3 ± 8.06	0.57 ± 0.02	9.46 ± 3.80	0.29 ± 0.04	bd	17.5 ± 1.76	0.21 ± 0.10	1.27 ± 0.82	0.11 ± 0.14	0.20 ± 0.05
2-NH2-BT	14.8 ± 11.2	1.03 ± 0.09	3.57 ± 1.43	0.12 ± 0.02	0.20 ± 0.09	26.3 ± 1.17	0.32 ± 0.15	1.12 ± 1.10	0.14 ± 0.07	0.14 ± 0.09
HOBT	85.8 ± 6.47	bd	4.30 ± 1.91	0.85 ± 0.14	0.72 ± 0.33	77.2 ± 14.3	bd	1.98 ± 0.48	0.68 ± 0.30	0.48 ± 0.34
MBT	15.4 ± 9.01	1.86 ± 0.23	2.34 ± 0.86	0.51 ± 0.08	0.16 ± 0.08	24.6 ± 2.96	2.09 ± 0.04	0.77 ± 0.63	0.15 ± 0.28	0.06 ± 0.04
MTBT	9.76 ± 6.91	1.15 ± 0.10	1.15 ± 0.39	0.14 ± 0.01	0.17 ± 0.08	17.5 ± 0.27	0.56 ± 0.36	0.48 ± 0.26	0.15 ± 0.03	0.13 ± 0.06
24MoBT	12.0 ± 6.88	1.57 ± 0.27	5.33 ± 2.20	0.25 ± 0.04	bd	14.8 ± 1.86	1.48 ± 0.08	1.72 ± 1.09	0.11 ± 0.14	bd
NCBA	23.9 ± 17.0	2.14 ± 0.18	0.57 ± 0.20	0.41 ± 0.08	0.67 ± 0.34	43.1 ± 7.24	1.44 ± 0.64	0.17 ± 0.09	0.31 ± 0.18	0.26 ± 0.24

OBS	18.6 ± 15.9	0.21 ± 0.01	6.09 ± 1.59	0.07 ± 0.01	3.45 ± 1.72	32.0 ± 1.91	0.05 ± 0.05	4.61 ± 2.60	0.18 ± 0.21	2.51 ± 1.45
CBS	11.5 ± 9.74	0.15 ± 0.02	1.98 ± 0.63	0.11 ± 0.02	5.64 ± 3.22	24.5 ± 1.32	0.07 ± 0.04	0.81 ± 0.20	0.12 ± 0.11	1.80 ± 1.98
BTs	**202 ± 134**	**8.68 ± 0.87**	**34.8 ± 13.0**	**2.74 ± 0.44**	**11.0 ± 5.86**	**277 ± 26.4**	**6.21 ± 1.47**	**12.9 ± 7.28**	**1.95 ± 0.59**	**5.58 ± 4.26**
BPA	**257 ± 76.4**	**84.7 ± 9.14**	**4.43 ± 1.45**	**7.80 ± 0.90**	**50.9 ± 27.1**	**279 ± 14.1**	**51.1 ± 17.7**	**1.40 ± 0.71**	**4.29 ± 6.68**	**38.6 ± 22.2**

* bd: not detected

** PB: Plastic burning, FB: Fruit bag burning, RT: Road traffic, AF: Agricultural film, LB: Livestock breeding

Table S3 The hazard score of each polymer.

Polymer	**Hazard score**
PE	11
PP	1
PS	30
PET	4
PMMA	1021
PVC	10001

* Taken from Lithner et al. (2011)

Table S4 Risk grade criteria of microplastics pollution.

Value of the risk index (H)	**<10**	**10-100**	**101-1000**	**>1000**
Risk category	I	II	III	IV

Table S5 Risk grade of five typical microplastic pollution source.

Value of the risk index	**10-100**	**100-1000**
$PM_{2.5}$	RT (71) AF (50) LB (69)	PB (186) FB (110)
PM_{10}	RT (81) AF (63) LB (72)	PB (309) FB (102)
Risk level	II	III

Table S6 Toxicity factors for specific compounds.

Species	Reference dose (RfD) (mg $kg^{-1}d^{-1}$)	Cancer slope factor (SF) (mg $kg^{-1}d^{-1})^{-1}$
PS	0.02	n.a.
PET	0.1	n.a.
BT	0.018	1.80×10^{-7}
MBT	0.004	n.a
DMP	10	n.a.
DEP	0.8	n.a.
BBP	0.2	0.00019
DEHP	0.02	0.014
DnOP	0.4	n.a.
BPA	0.05	n.a.

* n.a.: not available

** Taken from (Liu et al., 2023)

Table S7 The non-cancer (HQ) and cancer risks (ILCR) of the chemical species in $PM_{2.5}$ and PM_{10} from five sources.

		$PM_{2.5}$					**PM_{10}**				
		PB	**FB**	**RT**	**AF**	**LB**	**PB**	**FB**	**RT**	**AF**	**LB**
HQ	**PS**	6.32×10^{-6}	3.04×10^{-6}	5.57×10^{-7}	3.74×10^{-5}	3.26×10^{-6}	1.37×10^{-5}	6.32×10^{-6}	1.01×10^{-6}	5.31×10^{-5}	6.72×10^{-6}
	PET	1.81×10^{-5}	8.85×10^{-6}	1.06×10^{-6}	5.84×10^{-6}	1.22×10^{-5}	2.63×10^{-5}	2.19×10^{-5}	1.88×10^{-6}	1.00×10^{-5}	2.44×10^{-5}
	DMP	1.31×10^{-7}	2.10×10^{-8}	1.16×10^{-8}	6.52×10^{-8}	1.13×10^{-7}	4.07×10^{-7}	3.81×10^{-8}	1.62×10^{-8}	9.06×10^{-8}	1.69×10^{-7}
	DEP	4.49×10^{-6}	6.46×10^{-7}	6.83×10^{-8}	6.73×10^{-7}	2.42×10^{-6}	1.28×10^{-5}	9.14×10^{-7}	9.56×10^{-8}	1.25×10^{-6}	3.10×10^{-6}
	DBP	2.36×10^{-5}	5.97×10^{-6}	4.88×10^{-6}	1.13×10^{-5}	4.98×10^{-5}	5.80×10^{-5}	8.53×10^{-6}	6.42×10^{-6}	1.53×10^{-5}	6.99×10^{-5}
	BBP	3.84×10^{-5}	1.03×10^{-5}	4.02×10^{-6}	8.77×10^{-6}	5.11×10^{-5}	8.72×10^{-5}	1.42×10^{-5}	5.44×10^{-6}	1.47×10^{-5}	9.05×10^{-5}
	DEHP	3.13×10^{-4}	1.14×10^{-4}	9.10×10^{-5}	5.72×10^{-5}	3.54×10^{-4}	5.60×10^{-4}	1.75×10^{-4}	1.21×10^{-4}	8.53×10^{-5}	6.32×10^{-4}
	DNOP	2.35×10^{-5}	8.01×10^{-6}	1.18×10^{-5}	8.59×10^{-6}	2.95×10^{-5}	6.36×10^{-5}	1.48×10^{-5}	1.40×10^{-5}	1.36×10^{-5}	3.76×10^{-5}
	BT	3.92×10^{-6}	2.17×10^{-7}	3.15×10^{-5}	9.66×10^{-7}	/	1.06×10^{-5}	2.95×10^{-7}	3.57×10^{-5}	1.35×10^{-6}	6.51×10^{-7}
	MBT	7.52×10^{-6}	9.10×10^{-7}	1.00×10^{-5}	2.18×10^{-6}	6.85×10^{-7}	1.95×10^{-5}	1.93×10^{-6}	1.33×10^{-5}	2.82×10^{-6}	9.78×10^{-7}
	BPA	1.00×10^{-5}	3.31×10^{-6}	1.52×10^{-6}	2.67×10^{-6}	1.74×10^{-5}	2.10×10^{-5}	5.31×10^{-6}	1.99×10^{-6}	4.14×10^{-6}	3.06×10^{-5}
	ΣHQ	4.49×10^{-4}	1.55×10^{-4}	1.56×10^{-4}	1.36×10^{-4}	5.20×10^{-4}	8.73×10^{-4}	2.50×10^{-4}	2.01×10^{-4}	2.02×10^{-4}	8.96×10^{-4}
ILCR	**BBP**	1.46×10^{-9}	3.93×10^{-10}	1.53×10^{-10}	3.33×10^{-10}	1.94×10^{-9}	3.31×10^{-9}	5.40×10^{-10}	2.07×10^{-10}	5.60×10^{-10}	3.44×10^{-9}
	DEHP	8.76×10^{-8}	3.18×10^{-8}	2.55×10^{-8}	1.60×10^{-8}	9.91×10^{-8}	1.57×10^{-7}	4.91×10^{-8}	3.38×10^{-8}	2.39×10^{-8}	1.77×10^{-7}
	BT	1.27×10^{-14}	7.03×10^{-16}	1.02×10^{-13}	3.13×10^{-15}	/	3.42×10^{-14}	9.55×10^{-16}	1.16×10^{-13}	4.37×10^{-15}	2.11×10^{-15}
	ΣILCR	8.91×10^{-8}	3.22×10^{-8}	2.56×10^{-8}	1.63×10^{-8}	1.01×10^{-7}	1.60×10^{-7}	4.96×10^{-8}	3.40×10^{-8}	2.44×10^{-8}	1.80×10^{-7}

Figure S1 Sampling environments and sites for different sources.

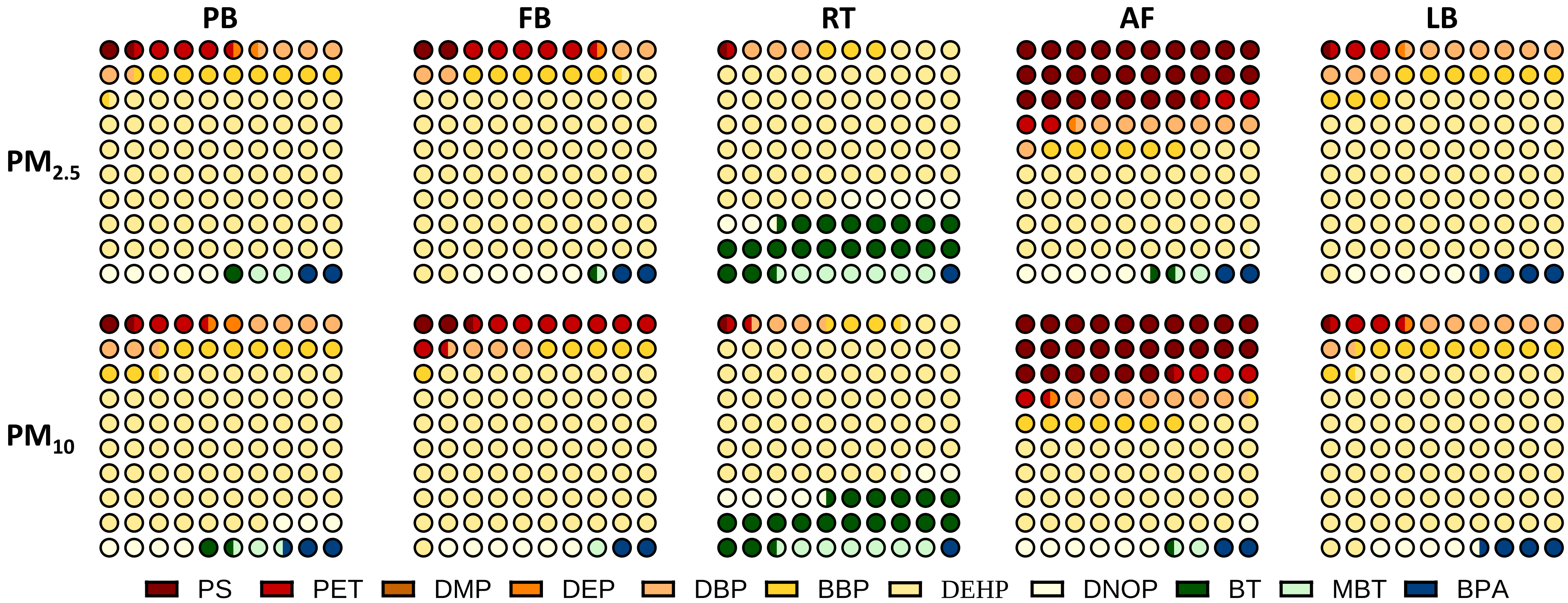

Figure S2 The non-cancer risks of MPs and plasticizers from five sources.

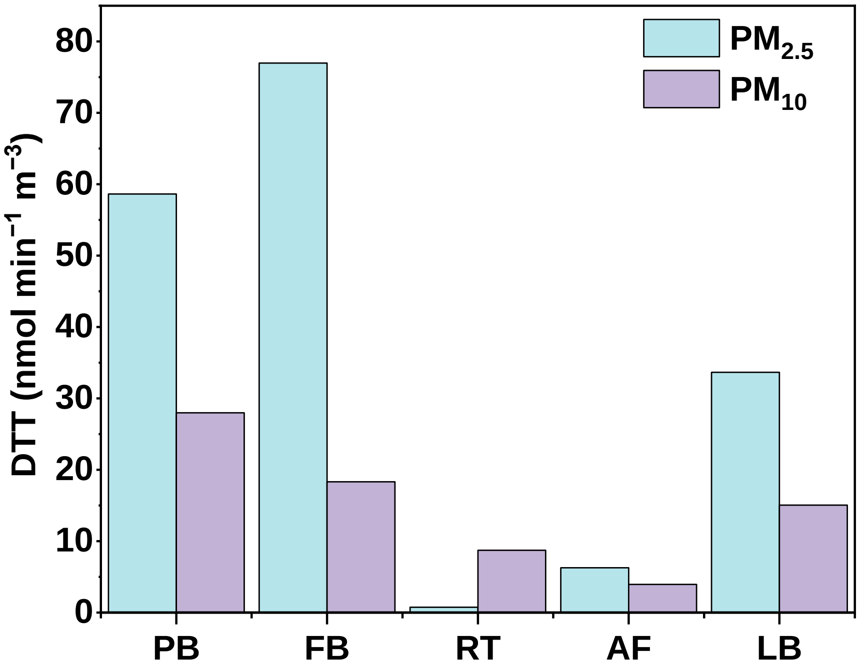

Figure S3 ROS generation capacity of $PM_{2.5}$ and PM_{10} from five sources.

Reference

Lithner D., Larsson Å., Dave G., Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition. Sci. Total Environ., 2011, 409, 3309-3324.

Liu M.X., Xu H.M., Feng R., et al., Chemical composition and potential health risks of tire and road wear microplastics from light-duty vehicles in an urban tunnel in China. Environmental Pollution, 2023, 330, 9.