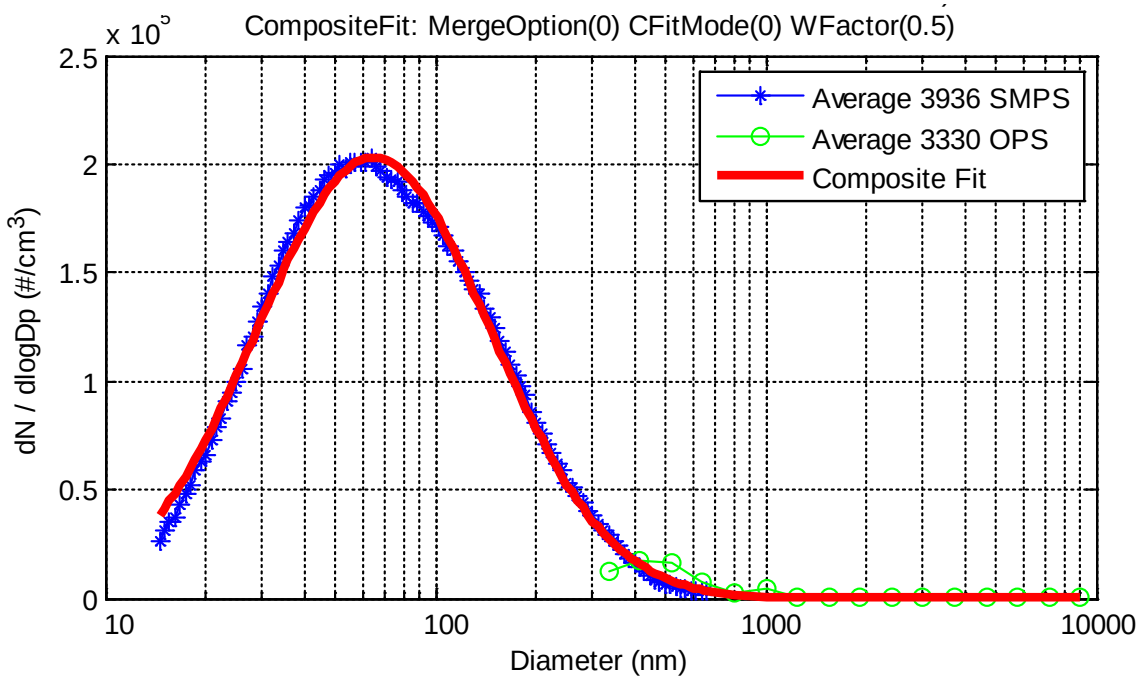
Supplementary file 1 – Element normalized weight (wt) and atomic (at) percentages of the four different brake pads that were used to collect PM2.5 samples as measured by energy dispersive spectroscopy (EDX)

Element	Brake-pad-1		Brake-pad-2		Brake-pad-3		Brake-pad-4	
	wt%	at%	wt%	at%	wt%	at%	wt%	at%
C	11.28	26.25	26.69	52.63	21.05	41.55	16.73	36.71
O	22.36	39.05	14.46	21.41	22.92	3.96	21.13	34.81
Mg	1.83	2.10			0.84	0.82	0.29	0.32
Si	1.14	1.13	0.05	0.04	1.94	1.64	0.98	0.92
S	1.87	1.63	0.47	0.34	1.93	1.43	1.03	0.85
Cr	0.40	0.21						
Fe	53.59	26.81	55.50	23.54	16.01	6.80	23.85	11.26
Cu	3.14	1.38			12.92	4.82	19.03	7.89
Zn	2.10	0.90						
Sn	2.28	0.54						
Na			0.94	0.97				
Al			0.41	0.36	2.08	1.83	0.73	0.71
Ca			0.45	0.27	1.82	1.08		
Mn			1.03	0.44			1.02	0.68
K					1.56	0.94	1.26	0.83
Ti					4.44	2.20	4.78	2.63
Zr					8.88	2.31	6.45	1.86
Ba					3.60	0.62	2.73	0.52

Supplementary file 2 – Example of combined (SMPS and OPS) size distribution of exposure to re-aerosolized PM2.5 emitted by ECE-NAO hybrid brake pads



Supplementary file 3 – Lung toxicity parameters in bronchoalveolar lavage fluid measured 24h post-exposure to re-aerosolized PM2.5 of different sources at very low, low, medium or high dose compared to controls. Data are expressed as mean ± SD (n=4-5 per group). Values regarded significant compared to control *$p<0.05$, **$p<0.01$ and ***$p<0.001$

PM2.5 source	Dose	protein	LDH	GSH	total cells	PMN		lymphocyte	IL-12p40		MIP-2		KC	
		mg/L	U/L	umol/L	E5/mL	abs. number		abs. numbe	pg/mL		pg/mL		pg/mL	
BW-1	control	129 ± 16	118 ± 21	2.11 ± 0.62	1.12 ± 0.16	2 ± 1		10 ± 9	9.22 ± 2.82		10.55 ± 2.26		30.92 ± 8.28	
	low	129 ± 11	115 ± 15	2.69 ± 0.54	0.74 ± 0.20	3 ± 6		20 ± 31	15.02 ± 7.82		8.56 ± 1.65		29.70 ± 10.98	
	medium	149 ± 14	138 ± 20	3.25 ± 0.51	1.07 ± 0.52	5 ± 5		4 ± 3	11.87 ± 2.04		10.65 ± 5.06		37.31 ± 23.74	
	high	126 ± 14	142 ± 26	2.35 ± 0.61	1.15 ± 0.26	3 ± 2		4 ± 2	8.64 ± 1.95		11.82 ± 5.58		42.35 ± 22.76	
BW-2	control	135 ± 24	147 ± 39	2.50 ± 0.88	0.67 ± 0.11	10 ± 6		5 ± 3	7.22 ± 2.57		4.42 ± 1.21		10.52 ± 4.60	
	low	159 ± 21	188 ± 96	4.29 ± 1.69	0.90 ± 0.17	29 ± 22		11 ± 10	13.49 ± 7.77		9.02 ± 2.06	*	32.07 ± 12.10	**
	medium	149 ± 24	132 ± 59	3.60 ± 1.46	0.92 ± 0.13	12 ± 5		10 ± 4	12.71 ± 3.35		5.00 ± 0.92		15.53 ± 2.90	
	high	146 ± 12	122 ± 8	2.58 ± 0.76	0.82 ± 0.22	5 ± 4		5 ± 4	8.93 ± 2.49		7.65 ± 4.49		20.38 ± 7.30	
BW-3	control	147 ± 39	107 ± 5	1.60 ± 0.77	1.09 ± 0.37	5 ± 11		6 ± 5	11.90 ± 3.58		4.16 ± 1.46		11.40 ± 2.87	
	very low	135 ± 12	137 ± 21	3.70 ± 2.12	0.89 ± 0.27	1 ± 1		5 ± 2	14.51 ± 1.37		9.47 ± 3.16	*	20.12 ± 5.87	
	low	138 ± 17	132 ± 23	3.40 ± 1.46	0.83 ± 0.28	1 ± 1		2 ± 1	15.46 ± 2.64		20.71 ± 7.55	***	30.32 ± 17.39	**
	medium	140 ± 21	127 ± 11	2.06 ± 0.37	0.85 ± 0.14	26 ± 12		5 ± 3	11.25 ± 3.00		71.44 ± 24.99	***	130.62 ± 21.63	***
BW-4	control	174 ± 45	169 ± 56	6.17 ± 5.16	1.10 ± 0.29	3 ± 2		5 ± 2	15.35 ± 10		8.54 ± 1.79		25.39 ± 3.28	
	low	129 ± 11	153 ± 19	4.02 ± 0.77	0.88 ± 0.28	16 ± 16		6 ± 2	13.72 ± 0.92		22.03 ± 6.28	**	40.36 ± 11.92	
	medium	144 ± 30	125 ± 18	3.54 ± 1.56	0.87 ± 0.25	12 ± 6	**	4 ± 2	26.67 ± 16.42		44.15 ± 22.11	***	79.49 ± 33.14	***
	high	170 ± 22	189 ± 96	3.76 ± 2.83	1.18 ± 0.19	89 ± 61	***	5 ± 2	19.20 ± 6.28		95.20 ± 16.58	***	179.78 ± 13.90	***
Tire/road wear	control	125 ± 24	104 ± 16	2.30 ± 0.98	0.70 ± 0.14	1 ± 1		6 ± 5	11.05 ± 4.56		6.19 ± 3.02		14.94 ± 3.74	
	low	131 ± 15	113 ± 7	2.58 ± 0.22	0.82 ± 0.11	2 ± 2		2 ± 1	15.11 ± 3.97		4.72 ± 1.28		13.02 ± 2.63	
	medium	129 ± 25	136 ± 6	2.42 ± 0.35	1.03 ± 0.19	1 ± 1		3 ± 2	15.55 ± 3.28		5.71 ± 2.42		13.47 ± 6.78	
	high	132 ± 21	115 ± 15	2.24 ± 0.37	1.04 ± 0.26	4 ± 2		4 ± 3	13.10 ± 3.09		5.90 ± 2.13		16.04 ± 6.40	
Modern stove	control	158 ± 21	136 ± 14	2.44 ± 0.68	0.95 ± 0.20	5 ± 8		6 ± 4	9.68 ± 1.15		5,39 ± 2,83		17.78 ± 2.11	
	low	145 ± 19	154 ± 44	3.50 ± 1.14	0.87 ± 0.13	12 ± 2		7 ± 4	12.41 ± 4.20		10.44 ± 4.07		31.62 ± 11.68	
	medium	153 ± 13	145 ± 19	3.49 ± 1.22	1.32 ± 0.25	59 ± 48	**	7 ± 2	7.17 ± 1.63		14.63 ± 2.90	**	40.54 ± 8.74	**
	high	166 ± 16	156 ± 54	3.64 ± 0.82	0.88 ± 0.13	28 ± 12	*	6 ± 8	8.26 ± 2.25		19.51 ± 5.81	***	61.33 ± 12.73	***
Old-fashioned stove	control	141 ± 21	127 ± 29	2.84 ± 0.67	0.90 ± 0.27	4 ± 4		8 ± 3	6.46 ± 2.31		14.10 ± 2.49		21.26 ± 6.29	
	low	133 ± 19	132 ± 44	3.96 ± 1.42	-	42 ± 27	*	8 ± 4	8.60 ± 2.36		6.28 ± 0.98	**	21.01 ± 5.53	
	medium	157 ± 19	173 ± 30	3.72 ± 0.88	1.34 ± 0.38	36 ± 26	*	3 ± 1	8.72 ± 1.06		10.75 ± 4.99		34.51 ± 5.24	
	high	160 ± 66	167 ± 48	4.73 ± 2.81	1.40 ± 0.41	44 ± 25	**	4 ± 3	8.32 ± 1.67		13.53 ± 2.85		43.16 ± 12.74	**
Diesel engine exhaust	control	147 ± 19	143 ± 53	2.66 ± 0.56	0.97 ± 0.22	4 ± 1		4 ± 1	14.69 ± 7.77		11.58 ± 2.85		24.61 ± 6.71	
	low	153 ± 29	157 ± 57	3.88 ± 0.82	0.79 ± 0.25	12 ± 8	*	6 ± 3	9.23 ± 2.51		5.95 ± 0.80		21.29 ± 4.83	
	medium	132 ± 17	142 ± 26	3.16 ± 0.56	1.24 ± 0.32	24 ± 9	***	6 ± 6	9.88 ± 2.12		14.45 ± 6.35		28.33 ± 8.02	
	high	159 ± 21	146 ± 19	3.04 ± 0.39	1.30 ± 0.33	69 ± 27	***	5 ± 4	9.91 ± 2.68		10.23 ± 1.56		26.78 ± 6.39	
Poultry farm	control	148 ± 21	132 ± 28	1.95 ± 0.93	0.86 ± 0.18	1 ± 1		11 ± 9	9.80 ± 4.28		6.81 ± 1.57		18.07 ± 3.18	
	low	136 ± 14	124 ± 27	2.89 ± 0.93	0.74 ± 0.23	32 ± 17	**	7 ± 3	17.58 ± 1.59	*	12.91 ± 3.50	**	27.67 ± 8.50	
	medium	155 ± 18	152 ± 49	2.74 ± 1.68	1.17 ± 0.28	156 ± 35	***	6 ± 3	31.31 ± 2.22	***	12.38 ± 1.41	**	44.44 ± 5.83	***
	high	166 ± 29	137 ± 22	1.79 ± 0.52	2.08 ± 0.82	223 ± 46	***	4 ± 2	36.32 ± 12.56	***	12.04 ± 1.67	**	48.46 ± 12.09	***

Supplementary file 4 – Summary of BMDL and BMDU of lung toxicity and hematological parameters 24h post-exposure to various PM2.5 sources

Parameter (BMR)		BW-1	BW-2	BW-3	BW-4	Tire/road wear	Modern stove	Old-fashioned stove	Diesel engine exhaust	Poultry farm
Total cells (20%)	BMDL	0.71	1.6	0.94	0.63	0.70	0.80	0.47	0.53	0.33
	BMDU	3.2	Inf	Inf	2.5	Inf	Inf	1.2	1.3	0.71
PMN lung (20%*)	BMDL	6.098	4.4297	1.090	1.002	3.771	1.179	1.542	1.294	0.3892
	BMDU	Inf	Inf	2.400	1.603	26.14	2.528	4.640	2.165	0.6074
IL-12p40 (20%)	BMDL	0.90703	0.08418	0.92032	0.14782	0.20681	1.67	0.23409	1.1979	0.00746
	BMDU	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	0.18967
KC (20%)	BMDL	0.35819	0.28347	0.04373	0.09716	0.37108	0.1665	0.28654	0.62358	0.19915
	BMDU	Inf	Inf	0.05872	0.12962	Inf	0.28773	0.73672	Inf	0.37567
MIP-2 (20%)	BMDL	0.37721	0.13318	0.00263	0.00681	0.31421	0.01938	0.69870	0.24119	0.08285
	BMDU	Inf	Inf	0.01907	0.04398	Inf	0.1179	Inf	Inf	2.1205
White blood cells (10%)	BMDL	0.28003	0.24185	0.10755	0.14473	0.15979	0.20867	0.33481	0.49862	0.2997
	BMDU	3.8911	5.0519	0.3751	0.30926	0.47783	0.7397	10.195	Inf	63.476
Neutrophils in blood (10%)	BMDL	2.0072	0	0.15075	0.37278	0.37434	0.26368	0.54967	1.0226	1.9717
	BMDU	Inf	Inf	0.78885	Inf	Inf	0.86246	Inf	Inf	Inf
Lymphocytes	BMDL	0.22054	0.21767	0.09741	0.13091	0.13984	0.20066	0.29352	0.41691	0.24503

Parameter (BMR)		BW-1	BW-2	BW-3	BW-4	Tire/road wear	Modern stove	Old-fashioned stove	Diesel engine exhaust	Poultry farm
blood (10%)	BMDU	1.0213	2.6939	0.31735	0.27052	0.37262	0.7733	3.2424	Inf	1.9301

BMR= benchmark response value

*BMR was set to 20% extra risk for effect on lung neutrophils.

BMD confidence interval ranging from zero to infinitive (Inf) reflects data obtained from PM2.5 sources and endpoints that were too scattered to enable dose response analysis. BMDL = Lower confidence interval BMD; BMDU = Upper confidence interval BMD.

Supplementary file 5 – Hematological parameters measured 24 h post-exposure to re-aerosolized PM2.5 of different sources at very low, low medium or high dose compared to controls.

PM2.5 source		WBC		neutrophils		lymphocytes		fibrinogen		vWF
		E^9/L		E^9/L		E^9/L		ng/mL		ng/mL
BW-1	control	9.70 ± 2.45		1.47 ± 0.24		7.76 ± 2.32		1.62 ± 0.48		148 ± 13
	low	6.79 ± 0.65		1.06 ± 0.33		5.43 ± 0.45		1.76 ± 0.33		147 ± 14
	medium	6.91 ± 1.21		1.36 ± 0.36		5.19 ± 0.81		1.61 ± 0.30		160 ± 22
	high	6.63 ± 1.65		1.57 ± 0.40		4.74 ± 1.24		1.60 ± 0.17		163 ± 11
BW-2	control	9.96 ± 1.97		1.42 ± 0.22		8.13 ± 1.73		1.88 ± 0.41		155 ± 4
	low	10.04 ± 2.35		1.60 ± 0.78		8.02 ± 1.64		1.64 ± 0.15		155 ± 9
	medium	9.15 ± 2.01		1.31 ± 0.27		7.43 ± 1.74		2.27 ± 0.63		161 ± 10
	high	7.58 ± 1.02		1.31 ± 0.28		5.91 ± 1.07		1.61 ± 0.38		159 ± 19
BW-3	control	7.73 ± 3.08		1.31 ± 0.13		6.05 ± 2.92		2.68 ± 0.15		131 ± 13
	very low	7.27 ± 2.37		1.20 ± 0.23		5.77 ± 2.14		2.55 ± 0.49		130 ± 17
	low	6.95 ± 2.37		1.32 ± 0.63		5.27 ± 1.94		2.93 ± 0.27		135 ± 19
	medium	4.93 ± 0.79		1.04 ± 0.34		3.66 ± 0.60		2.37 ± 0.33		131 ± 17
BW-4	control	10.26 ± 1.60		1.63 ± 0.23		7.98 ± 1.60		2.41 ± 0.10		137 ± 11
	low	10.36 ± 1.87		1.54 ± 0.13		8.27 ± 1.71		2.86 ± 0.48		143 ± 9
	medium	7.13 ± 0.89	*	1.06 ± 0.35	*	5.62 ± 0.52	*	2.80 ± 0.22	*	152 ± 13
	high	5.80 ± 0.68	***	1.17 ± 0.16	**	4.19 ± 0.48	***	3.19 ± 0.32	**	120 ± 8
Tyre/road wear	control	8.70 ± 1.47		1.25 ± 0.11		6.96 ± 1.34		2.82 ± 0.36		155 ± 27
	low	9.85 ± 1.87		1.38 ± 0.27		8.05 ± 1.53		2.71 ± 0.17		130 ± 9
	medium	8.15 ± 2.26		1.22 ± 0.42		6.57 ± 1.95		2.73 ± 0.50		134 ± 16
	high	5.97 ± 1.40		1.19 ± 0.25		4.45 ± 1.12	*	2.78 ± 0.22		134 ± 16
Modern stove	control	9.84 ± 1.87		1.62 ± 0.31		7.72 ± 1.50		1.80 ± 0.39		152 ± 5
	low	6.95 ± 1.48		0.96 ± 0.17	**	5.74 ± 1.32		1.99 ± 0.18		162 ± 22
	medium	8.88 ± 0.84		1.40 ± 0.25		7.05 ± 0.63		2.10 ± 0.15		127 ± 10
	high	5.97 ± 2.18		0.96 ± 0.36	*	4.74 ± 1.77		2.25 ± 0.18		135 ± 14
Old-fashioned stove	control	9.04 ± 2.28		1.28 ± 0.41		7.39 ± 1.91		2.53 ± 0.09		133 ± 22
	low	10.35 ± 2.95		1.29 ± 0.24		8.66 ± 2.72		2.60 ± 0.46		131 ± 19
	medium	6.92 ± 1.33		1.13 ± 0.29		5.51 ± 1.11		2.65 ± 0.31		138 ± 21
	high	7.74 ± 2.34		1.31 ± 0.44		6.10 ± 1.94		2.37 ± 0.12		130 ± 5
Diesel engine exhaust	control	9.15 ± 1.52		1.38 ± 0.71		7.43 ± 1.70		2.62 ± 0.42		121 ± 18
	low	8.16 ± 1.61		1.22 ± 0.30		6.63 ± 1.34		2.40 ± 0.17		126 ± 10
	medium	8.94 ± 2.16		1.34 ± 0.28		7.26 ± 1.87		2.80 ± 0.32		121 ± 15
	high	8.17 ± 1.94		1.44 ± 0.70		6.37 ± 1.40		3.14 ± 0.76		122 ± 3
Poultry farm	control	11.21 ± 2.44		1.78 ± 0.18		8.96 ± 2.25		3.33 ± 0.51		146 ± 9
	low	8.11 ± 0.66	*	1.14 ± 0.30	**	6.60 ± 0.42		1.78 ± 0.35	**	138 ± 13
	medium	9.65 ± 2.22		1.30 ± 0.23	*	7.93 ± 2.03		1.60 ± 0.17	***	148 ± 10
	high	7.87 ± 1.74	*	1.71 ± 0.28		5.79 ± 1.44		2.14 ± 1.20	**	143 ± 20

Data are expressed as mean ± SD (n=4-5 per group). Values regarded significant compared to control *p<0.05, **p<0.01 and ***p<0.001