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Production and characterization of recovered Carbon Black (rCB) by waste tire pyrolysis as a potential Carbon Black (CB) substitute

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Supplementary Material (SM)

SM1. Experimental setup for waste tire pyrolysis

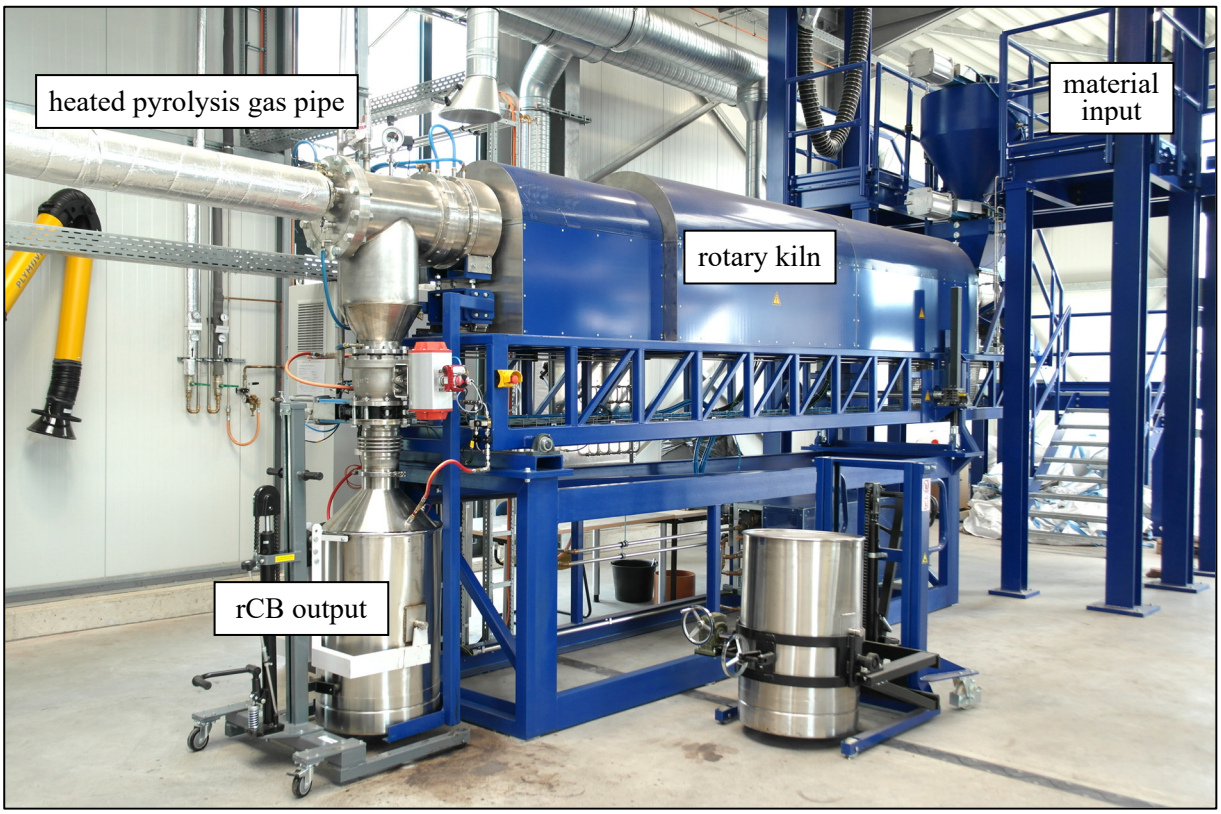

Figure S1. Photo of the semi-industrial rotary kiln reactor at the metabolon institute of TH Köln (Lindlar, Germany)

SM2. Characterization of input material

Table S1. Particle size distribution of input material (rubber granulate mixture from various scrap tires of cars, trucks and bicycles, as received)

Particle size [mm]	Absolute [wt%]	Cumulative [wt%]
<0.25	0.14%	0.14%
0.25-0.5	0.17%	0.31%
5.0-6.3	1.82%	2.13%
0.5-1.0	3.73%	5.86%
1.4-2.0	8.93%	14.79%
2.0-3.15	10.71%	25.50%
3.15-5.0	57.53%	83.03%
5.0-6.3	16.83%	99.86%
6.3-8.0	0.12%	99.98%
>8.0	0.02%	100.00%

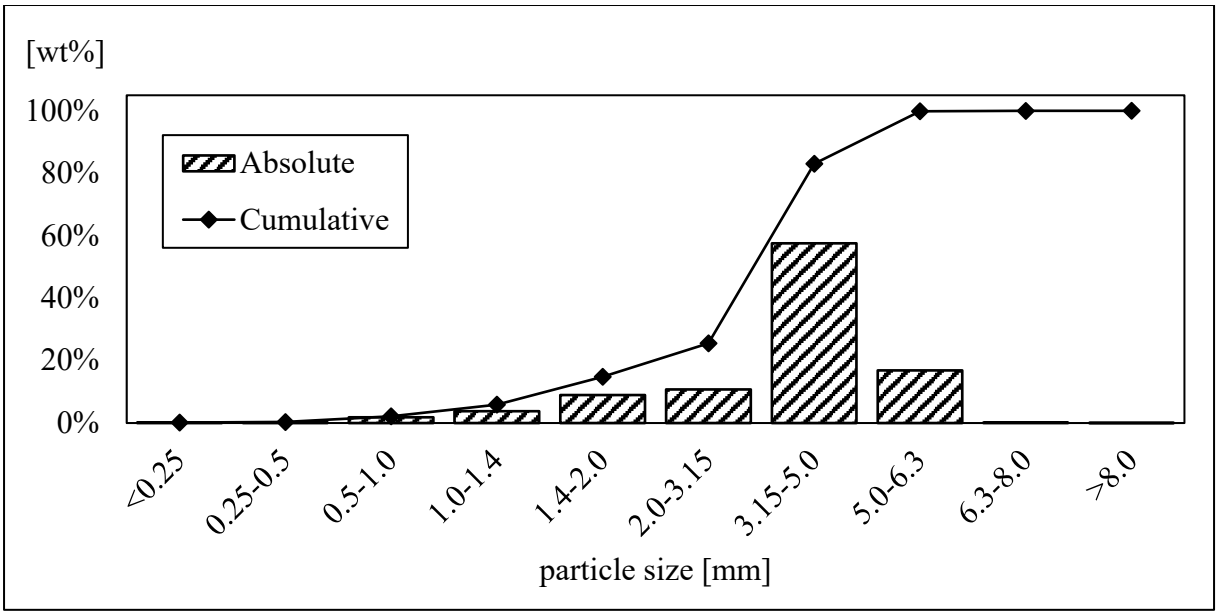

Figure S2. Sieve analysis curve of input material (rubber granulate mixture from various scrap tires of cars, trucks and bicycles, as received)

SM3. Preliminary study in laboratory

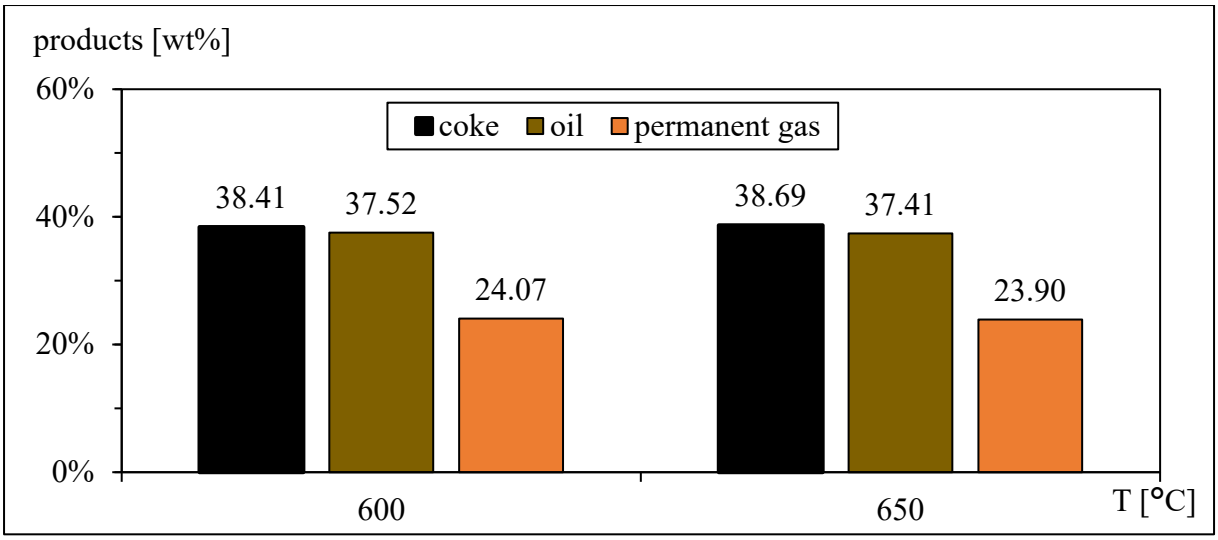

Figure S3. Laboratory experiments on waste tire pyrolysis (rubber granulate mixture from various scrap tires of cars, trucks and bicycles): distribution of pyrolysis products (coke, oil and permanent gas) at 600°C and 650°C pyrolysis temperature

SM4. Upscaling experiments in semi-industrial a rotary kiln

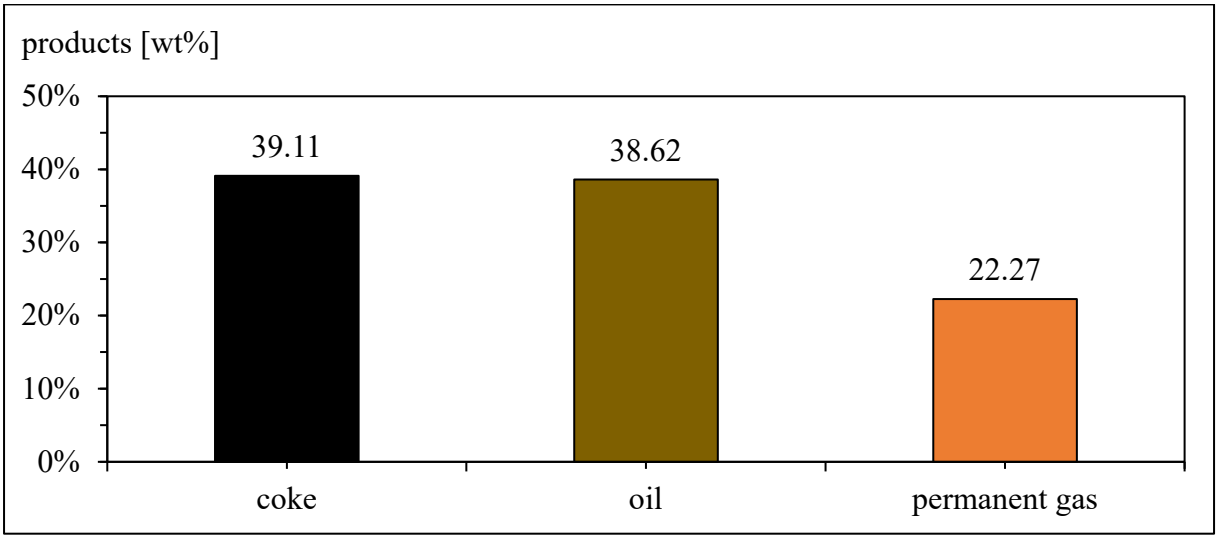

Figure S4. Experiments on waste tire pyrolysis (rubber granulate mixture from various scrap tires of cars, trucks and bicycles) in semi-industrial rotary kiln: distribution of pyrolysis products (coke, oil and permanent gas) at 650°C pyrolysis temperature

Table S2. Process parameters for experiments on waste tire pyrolysis (Rubber Granulate (RG) mixture from various scrap tires of cars, trucks and bicycles) in semi-industrial rotary kiln at 650°C pyrolysis temperature

Parameter	Value	Unit
heated kiln length	3,500	mm
kiln inner diameter	300	mm
residue time (heated zone)	60	min
horizontal inclination	2.0	°
kiln rotation speed	2.0	rpm
material feed rate	8.9	kg/h
inert gas input (nitrogen)	7.5	m^3/h
energy consumption feeding system	0.02	kWh/kg_{RG}
energy consumption kiln rotation	0.04	kWh/kg_{RG}
energy consumption kiln heating	1.04	kWh/kg_{RG}
energy consumption cooling system	0.20	kWh/kg_{RG}
energy consumption total	1.30	kWh/kg_{RG}

Table S3. Permanent gas composition for experiments on waste tire pyrolysis (rubber granulate mixture from various scrap tires of cars, trucks and bicycles) in semi-industrial rotary kiln at 650°C pyrolysis temperature

Gas component	[Vol%]	Standard deviation [Vol%]
CO	2.35	0.09
CO_2	3.84	0.23
H_2	31.87	0.53
H_2S	0.0012	0.0002
C_xH_y	62.30	0.56

SM5. Analysis of rCB produced in rotary kiln

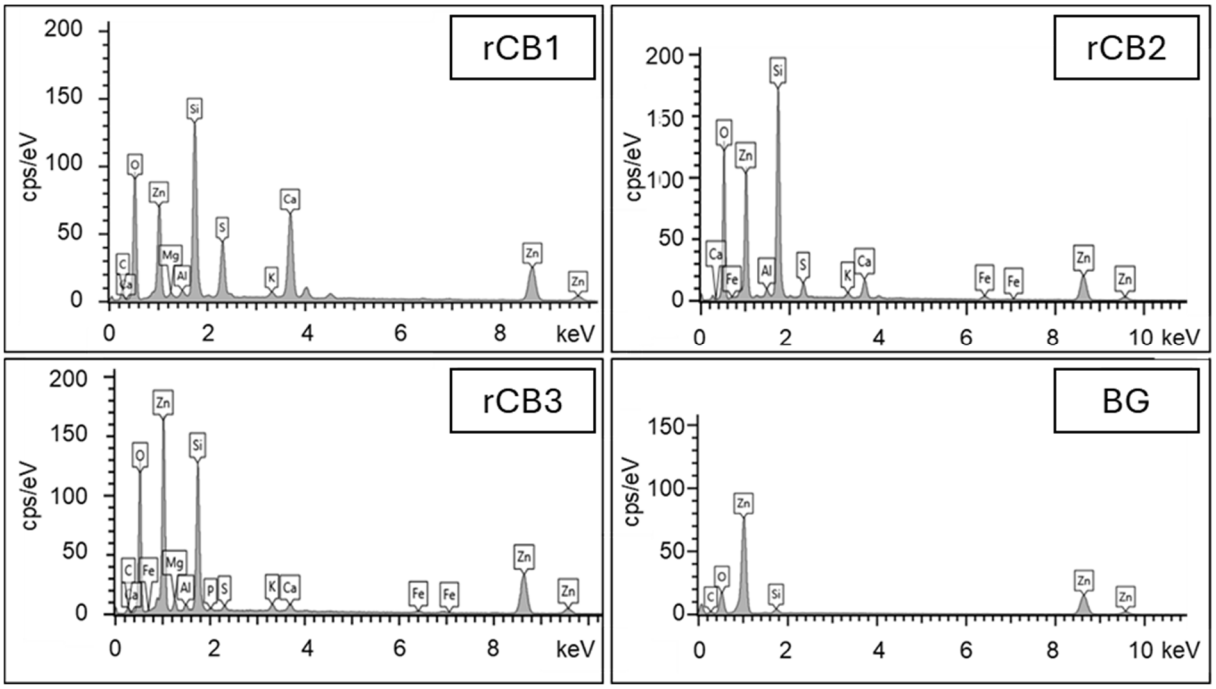

Figure S5. Elemental analysis (EDX) using SEM of the ashed samples rCB1, rCB2, rCB3 and BG

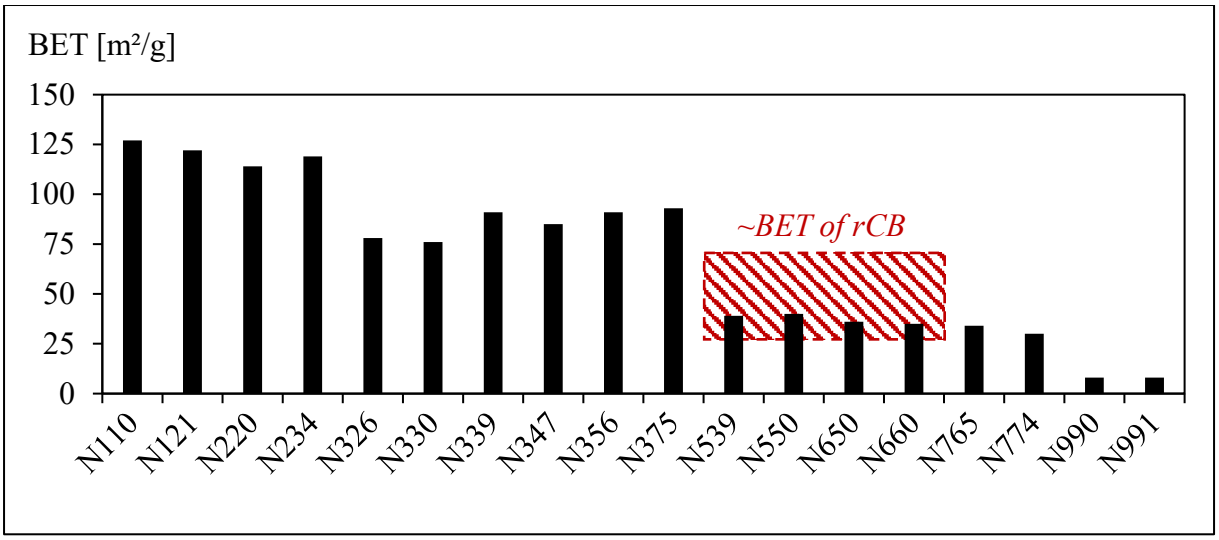

Figure S6. Rough qualitative classification of the BET surface area of rCBs compared to ASTM D1765-23b standardized CBs