Supplementary information (SI)

Title: Evaluation of Electrostatic Separation of Microplastics from Mineral-Rich Environmental Samples

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Text S1: Protocol

Instrument: 2nd prototype of the electrostatic separator (Korona Walzen Scheider (KWS), hamos GmbH). Schematic of the design is presented in Fig. S1.

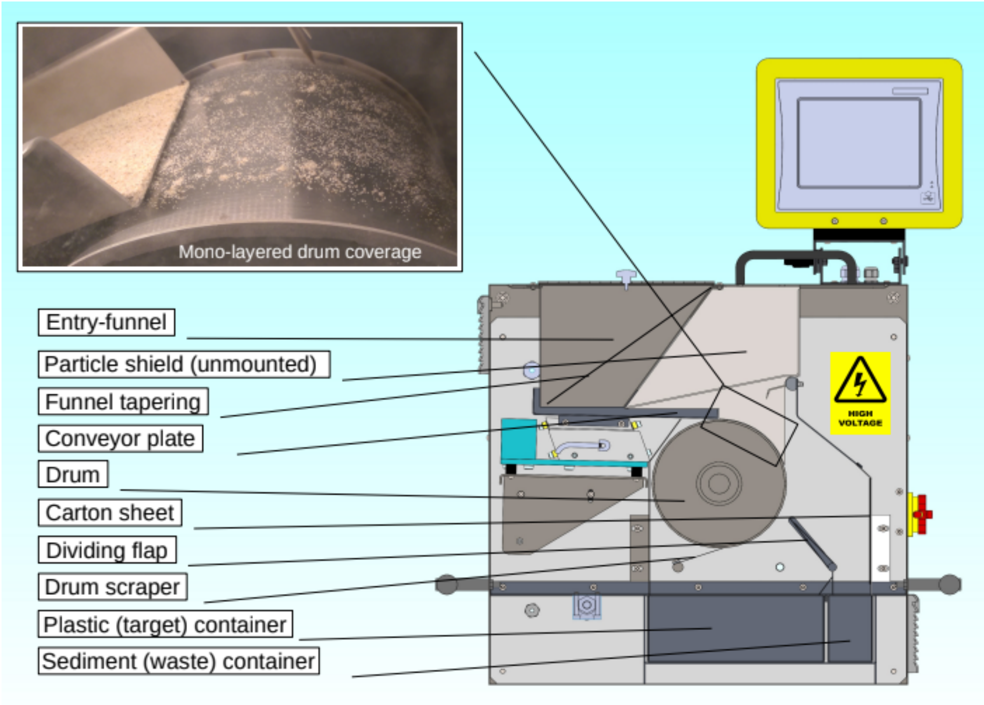

Fig. S1: KWS descriptive schematic with labels of key components; Top-left corner: Presentation of mono-layering of sediment necessary for proper functionality. KWS Scheme modified from hamos GmbH.

Test sediment samples and spiked microplastics (MP): as reported in associated paper section Methods and Materials – Test material: (a) – (d) and Table 1.

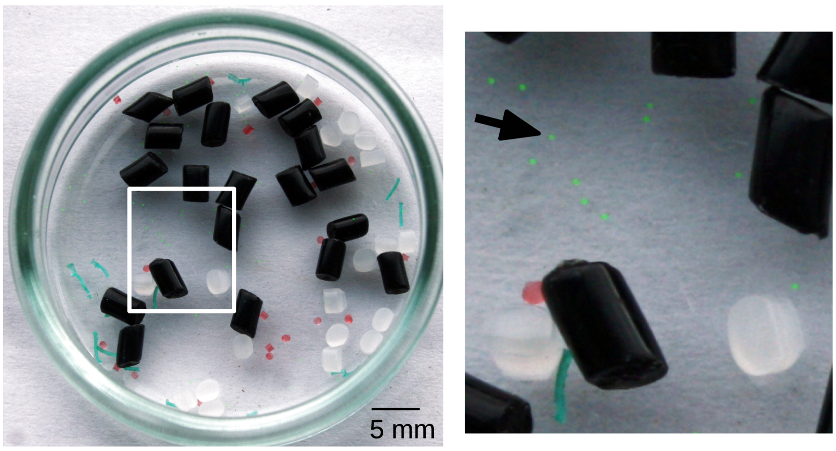

Fig. S2: Spiked MP as listed in Table 1 in the associated paper. The two smallest size groups of MP are not visible by eye, however have an appearance alike the green fluorescent spheres of 125 – 150 µm in size as shown in the close up (white rectangle, black arrow).

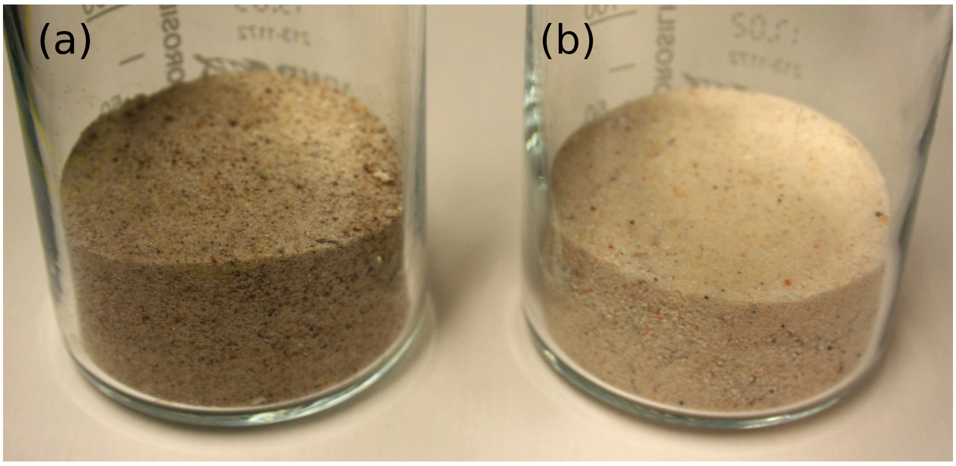

Fig. S3: Sample matrices (a) beach sand and (b) quartz sand.

Procedure

1. **Cleaning**: KWS has to be thoroughly cleaned between samples to prevent cross-contamination. In case the KWS was not used (and thus automatically cleaned), start an ‘empty’ run with higher drum rotations and vibration values (approx. 20%). After that, vacuum-clean the conveyor plate, funnel, etc.. Wash the MP collection container with microplastic free (MPF) water and dry. See a descriptive figure of the KWS above (Fig. S1). Empty the sediment collection container into a waste container.

2. **Insert**: Boot up KWS control screen. Insert half of the previously freeze-dried sample (as e.g. shown in Fig. S3) into the entry-funnel. Then add the prepared internal standard (spiked MP, Table 1, Fig. S2) from the glass petri dish directly into the funnel by rinsing it with remaining sediment sample (at least three times). Note the Internal Standard numbers.

3. **Run**: Turn on illumination, voltage (1.), drum (2.) and vibration (3.) of the KWS according to the following **Standard parameters** (see Fig. S4 for an image of the KWS screen displaying the settings) :

High voltage: **22 kV**
Vibration: ~**1 %** (final) **- ~13 %** (initially)
Drum: **4 %**
Position flap: **19.5°**

The vibration should be adjusted so that particle coverage on the drum is mono-layered, see Fig. S1, to guarantee optimal separation results. For large sample volumes where the funnel is initially filled with sediment the vibration should be set to ~ 13% (by experience, adjust depending on coverage on the drum). Mind that the entry-funnel should not be in contact with the vibration plate as vibration may then be dampened.

4. **Repeat**: When no remaining sample material is on the conveyor plate (or the drum begins to be multi-layered) pause the KWS and add the content of the target (plastic) container again to the funnel. When pausing/ stopping a run, power off components in the following order: vibration, drum, voltage. Carefully move the sediment in one corner of the target container (e.g. by knocking) and slowly (avoiding formation of dust) re-insert sample into the entry-funnel and start a new run. In the case of the funnel becoming clogged before being noticed, leading to the sample passing through the KWS without proper separation, re-add the content in the sediment container to the entry-funnel. Given the possibility of such cases, it is advantageous to empty the sediment container following a well-controlled run to avoid having to re-include previously separated sediment volume. Repeat run 4 times (5 runs total).

5. **Finish:** Following the final run, turn off the voltage and increase the vibration again (> 20 %) in order to 'flush' all remaining particles into the containers. Flip the drum scraper (copper plate) in order to empty the trapped sediment into the MP container.

6. **Transfer**: Weigh both the content of the left and right container to determine the total mass reduction. Transfer the content of the MP container into the density separation device and perform a density separation (here according to Enders et al., 2020). Subsequently, determine spiked MP numbers under a binocular microscope (florescent particles with help of a UV lamp). Rinse the left container with MPF water and filter onto a 10 µm filter, count any remaining MP and add to numbers previously-counted following density separation. It can help to remove the smaller MP particles when counting with a wet needle from the filter to avoid double-counts. Check all surfaces of larger particles.

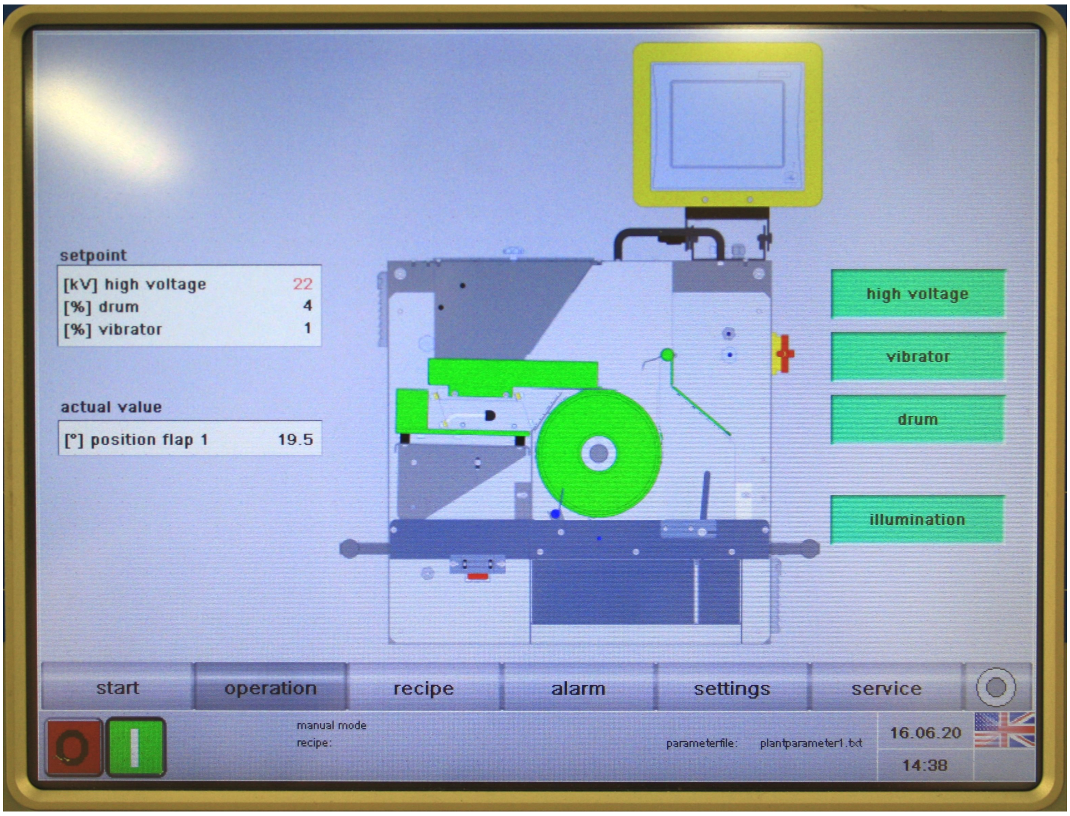

Fig. S4: KWS display showing the standard settings of the test runs.

Table S1: KWS recovery rate data [%] (A – K) for the differently-sized MP that the test sediment samples were spiked with. Recovery rates for the density separation alone are presented (L - N). Median and percentiles are calculated for dust and non-dust beach sand samples, commercial sand and density separation only. Below are the mass reduction rates for the individual tests and their averages.

	Recovery rates [%]																								
	(a) Beach sand (20 kV)		**(a) Beach sand (22 kV)**		**Med-ian**	**Percen-tiles [25, 75]**	**DS correct.**	**b) Commercial sand (22 kV)**			**Med-ian**	**Percen-tiles [25, 75]**	**DS correct.**	**(c) Beach sand + dust (20 kV)**		**(c) Beach sand + dust (22 kV)**		**Med-ian**	**Percen-tiles [25, 75]**	**DS correct.**	**Density separation**			**Med-ian**	**Dust only**
Spiked MP	**A**	**B**	**C**	**D**				**E**	**F**	**G**				**H**	**I**	**J**	**K**				**L**	**M**	**N**		**O**
4 mm, PA66 pellet	98	100	95	100	99	[97, 100]	99	100	100	90	100	[95, 100]	100	100	100	100	90	100	[98, 100]	100	100	100	100	100	95
2 mm, HDPE pellet	100	100	100	95	100	[99, 100]	100	100	95	90	95	[93, 98]	95	100	95	100	100	100	[99, 100]	100	95	100	100	100	93
2 mm, PE fibre	95	100	70	65	83	[69, 96]	83	95	80	80	80	[80, 88]	80	90	75	80	60	78	[71, 83]	78	90	100	100	100	100
450 µm, PA6 pellet	98	83	100	90	94	[88, 98]	94	100	80	75	80	[78, 90]	80	38	45	65	80	55	[43, 69]	55	100	90	100	100	25
125 – 150 µm, PE sphere	n.d.	n.d.	77	47	62	[55, 70]	78	48	32	21	32	[27, 40]	48	n.d.	n.d.	87	82	85	[84, 86]	100	97	82	84	84	n.d.
63 – 74 µm, PE sphere	19	62	n.d.	36	36	[28, 49]	59	27	45	23	27	[25, 36]	49	33	35	57	49	42	[35, 51]	64	67	85	78	78	67
20 – 27 µm, PE sphere	2	10	n.d.	13	10	[6, 12]	45	26	47	33	33	[30, 40]	68	2	5	5	29	5	[4, 11]	60	65	81	63	65	0
Mass reduction [%]	76.4	71.2	91.6	94.0				9.8	18.1	22.9				79.1	61.6	92.6	95.5								
		73.8		**92.8**						**16.9**					**70.4**		**94.0**								