Electronic Supplementary Information (ESI)

An approach for extraction, characterization and quantitation of microplastics in natural marine snow using Raman microscopy

Shiye Y. Zhao,^{a b} Meghan Danley, ^c J. Evan Ward, ^d Daoji Li^a and Tracy J. Mincer^{*b}

^a State Key Laboratory of Estuarine and Costal Research, East China Normal University, 3663 North Zhongshan Road, Shanghai 200062, China

^b Marine Chemistry & Geochemistry, Woods Hole Oceanographic Institution, 266 Woods Hole Road, Woods Hole, Massachusetts 02543, United States.

^c Marine Biology, University of New England, 11 Hills Beach Rd, Biddeford, Maine 04005, United States.

^d Department of Marine Science, University of Connecticut, 1080 Shennecossett Road., Groton, Connecticut 06340, United States.

*Corresponding author: Tracy J. Mincer; E-mail: tmincer@whoi.edu. Marine Chemistry & Geochemistry, Woods Hole Oceanographic Institution, 266 Woods Hole Road, Woods Hole, Massachusetts 02543, United States. Fax: 508-457-2075.



Fig. S1 Comparison between scrapings sampled from a Falcon tube and extracted particles from marine snow (PP: polypropylene; PS: polystyrene)



Fig.S2 Variant surface color appearances of the blue plastic particle extracted from marine snow and the scraping sampled from a Falcon tube cap using 8X digital zoom.



Fig. S3 Efficiency of hydrogen peroxide (15%, 30%) and hydrochloric acid (20%) to remove organic of biological origin within 24 h incubations. Note similarity among the 15% and 30% hydrogen peroxide treatments.



Fig. S4 Averaged Raman spectra of microspheres (a, MS: fluorescent green, polyethylene microspheres), polyethylene fragments (b, PE) and polypropylene fragments (c, PP) before (-B) and after (-A) 15% H_2O_2 treatment; Cluster analysis of the Raman spectra (MS, PE, PP) based on a Euclidean similarity matrix (d).



Fig. S5 Raman spectrum of the additive Hostasol Green (red trace) and a spectrum of a fragment extracted from marine snow (black trace), illustrating how this colorant could possibly mask the base polymer spectrum (scale bar: $100 \mu m$).

Table 51: Particles were classified into two groups: fragments (e.g., hard and flexible pieces), fibers. Colors of MP were recorded and identified as one of three color tone types: light (white, yellow, yellow-brow); mid (green, red, blue, etc.); dark (grey, black, dark

			Visual	Identificat	ion			Confirm	ned by Rai	nan			N	lo spec	rtra					P
			Shape		Color			Shape		Colo	r		S	hape		Color				s
Sample	Volume (ml)	total particle	Fiber	fragment	light	mid	l dark	Fiber	fragment	light	mid	dark	F	iber	fragment	light	mid	dark		F
Α	13	8		3 5	1	. 6	51	2	3		14	L 0		1	2	0	2	1	A	
A2	14	13		3 10	4		63	1	4		31	1 1		2	6	1	3	4	A2	
в	14	15		5 10	3	9) 3	1	9		37	0		4	1	0	2	3	В	
B2	14	14		2 12	4	1 9	91	1	12		4 8	3 1		1	0	0	1	. 0	B2	
С	13.5	9) :	: 7	2	. 6	5 1	0	6		06	50		2	1	1	0	2	С	
C2	14	10		L 9	1	9	90	0) 9		09) 0		1	0	1	0	0	C2	
D	13.75	8		I 7	0	1	8 0	0) 6		06	50		1	1	0	1	. 1	D	
D2	14	7	· .	4 3	3	4	4 0	3	2		2 3	30		1	1	1	1	. 0	D2	

А
A2
В
B2
С
C2
D

No spect	tra					
Shape			Color			
Fiber	1	ragment	light	mid	dark	1
	1	2		0	2	1
	2	6		1	3	4
	4	1		0	2	3
	1	0		0	1	0
	2	1		1	0	2
	1	0		1	0	0
	1	1		0	1	1
	1	1		1	1	0

Table S2: Classification of fragments according to size (in micrometers, um) and shape. Text in red refers to fragments that did not have sufficient Raman spectral signature to positively identify.

A-size	A2-size	B-size	B2-size	C-size	C2-size	D-size	D2-size
406	224.6	249.1	351.5	500.3	1018.8	562.2	403.6
344.6	693.1	209.2	283.4	450.9	481.9	276.3	170.6
803.5	378.5	319.4	70	313.1	528.4	363.8	803.3
717	232.6	513.1	275.7	315.9	584.4	243.8	185.4
1482.1	508.8	342.9	172.5	113.5	1556.3	356.5	243.6
347.4	371.8	888.4	593.8	461.6	475.9	209.7	165
449.1	1192.9	370.9	578.4	271.6	491.9	64	181.6
115.1	1045.5	347.5	341.6	303.4	633.4	267.2	
	468.8	245.2	364.4	84.8	461.9		
	395.4	517.9	479.4		426.6		
	270.6	246.8	275				
	345.7	395.9	286.6				
	325.7	502.2	167.7				
		722.4	212				
		309.1					

Table S3: Particles identified in this study with corresponding Remain spectra, scale but and estimated fragment size.

Count Nample	Imp	Nule har (sm)	Nor (see	Palymentope	Species (Vales red species referenced species black species species of samples)	Nates
~	1000			na feljesjúnstruje jihásjúni	9 O	and games Polycopean, 2010 (27), and 2020 (2011 Seeling 10). Bit and 2020 of the antibacture of the article between specific pairs of 2011 (2010) (20
	110				0	The first basis (the constant)
84 10	62			-	lymthystorytorymu.	actoriación da da laga
**	122		-	Mantana	<u>Il manan</u>	1984 March & Barner M. (1984). I Fillmant & Ant (1984) and T. D. Yanaki Matthews (1984). And the signal
	- Stor			The Restaur Clause Cold		
	and the				landerslagerstagersen.	
**			-	and the production of the prod	1 al and 1	PRODUCT Rescond Proc. Product and the optimistic of the second se
	0			an folgolynae		PROJECTS A RESIDENCE PROJECT PROJECT RESIDENCE AND COMPANY
-	Y				(Contraction of the Contraction	
81.0 10	~			na <mark>phini pana</mark>		1 Make deep setting part and Mark balanching part of the part o
a	-			and following		PROFESSION REPORT PROFESSION
				HI Bala Mana		100-100-a 1 1 2 contrag (Matt on Onlym Ac Art
-	°					
				na hayaqaa ing		1. Makar Asino untroductional and Thomas School Asino Spacific particular (PC) Engine Minkey parts (2014) 1. Web and Makara and much assessment compared, 2013 Web and 1. Web and parts of press
	and the second			an folgetigten		PROFESSION REPORT PROFESSION
	St 2.			n, Mpagan nge		and games the property of the effect of the contracting state. In the contract data with any part of the state that there is not be used of the contract of the contract data.
	J.					Thermony may associate annual companie, Min Wood, J. 19 Landing and J. Ann
	Ser.			an Mangalan Angar pikake ana		1. Molecular data subtract parts and Taxin Index And Alam Specific parts (PT) Expect Philaderparts (PDA) 1107-021 Manager and parts in a second compared, 101-75 and 1107-020 April part of press
	105			N. I. Tuffalian	- ded	10.00ml 00.0mg/colors
	1 m					on game tall, som i Priva I free Personal greet for an 1 Material Association (game and four black down (game)) game and game black game and game black and game and
-	and -				in the second se	press
	March Con			n folgogine foge jihatejant	Charles and a started and a started and a started at the started a	1. Model Administration (particular States States and the Specific particular STATE States Compared Administration of the States States and A states and a state of the States Compared Administration parts.)
	a mark			n Magagina Augar phanyan	 	and queries (SAN), SERA (Proce, J. (SM), FAN Sandrag, SM, SAN one. 1. Hole of other systems and "Baset Solida Antes Spaces, particular and the system of particle systems and particle particular anomaly compared, SER 2014, STATure Character, SM particular anomaly compared, SER 2014, STATure Character, and at particular anomaly compared, STATURE Character, and at state of the systems of the system of the system of the system of the system of the system of the system of the system of the system of the system of the
				and the second second	Lm	196.00%-to-1 2-0 and agout 7-booksg186.096-to-17-
-					0	-
	P			Higheigh Sacarly Hill Phageline (edited satisfies)	· · · · · · · · · · · · · · · · · · ·	White the Party angle math
	-			TT Nyajiaka	0	1980 Michael Banacag 1980 Michael Inkolina I Sciences Michael Inkolina (Sciences) and
	+ 1			and Projections		THE REPORT REPORT OF THE ATTICATION AND AND AND AND AND AND AND AND AND AN
	\sim					
	- 2 .			the follow	and a starting and a starting and	10.000 a 100 A a paraman
	TON			na Argagina Arga	مىلىكى يەرىكى مەرىكى مەرىك مەرىكى مەرىكى	sel-parte PT, MEA ST, etc.) PRI (PER-badag SR), Miran J Mirar Anno Hiller Ayan and Yoan Marke Anno Specifi parts APT (Paper Medicipant (PUA)) (PER-ar Annose Ry and A control compared, NE 70 at 117 States Annose P PRI
	1000			a Managina Page		ani gana 19, 100 107 alia 200 100 hading 100 km alia Nina Anis anto ang ang ang ang ang ang ang ang ang ang ang ang ang ang ang ang ang ang
-	the second				le-le-le-	and a construction of the State
	~			na pilato ana	-human	Bode Anno Selle space of Bode Kone Alike Specific parts (PC ExpectRological parts) (1074) (Bode part of parts a second compared, 30178 and (1074) (adopted of press
	-			na <mark>Majagina Naja</mark>	lennellen	end queries (MA), URA-AP-Leo, J. (MA), FMI Standing, URA, ML and J. Hadrad Adam soliton-system and Hannis Makad Adam Spacelin pattern (PT). Forgate Philodocycana. (FUA), URA-AR Researce (Ing and Art and Art and Art and Art and Art and Art and Art and Art and Art and Art and Art and Art and Art and Art and Art Art and Art and Art and Art and Art and Art and Art and Art Art and Art and Art and Art Art and Art and Art and Art Art and Art
	A			and Perspectation Property		ani gana 19, 100 107 alia 200 100 hading 100 km alia Nina Anis anto ang ang ang ang ang ang ang ang ang ang ang ang ang ang ang ang ang ang
					lenalliterature in line official	and a construction of the State
	~~			Mangana Ingar philosophia	Jametto and the second second	1 Make Antonio Marco yana and Make Antonio Mangolom patro (19) Engle Physical yang (19) 1074 or Barrow Ing and A construction paperski, WE Water 11976 and 11976 and page
	-			na <mark>Pelpapina Inge</mark> pikakejana		and queries (Fally, 1978), 477-108, 1 FBN, 1 FBN, 1987, 1988, 1988, 1988, 1989, 1980, 1989, 1980, 1989, 1980, 1989, 1980, 1989, 1980, 1989, 1980, 1989, 1980, 1989, 1980
	A		-	ra Managina majar	mul	and quarter PP 1000-1070 (etc.) 1000 (PD banding 1000 (etc.) and Barbard Anton collectory and Theore Anton Anton Spacelin games college (Policy and and Spaceling Anton Spaceling
-	Contraction of the				I II II II I	per anti-anti-anti-anti-anti-anti-anti-anti-
	-			na Mangana Inga Jihan Jan		Bolie Auto (Alte (Alte and Alte Solar Alte Alte Spin) pathod (Y) Experimental pathod (Alte Solar Alterna and and Alterna and any advantal (Alter Solar 1995) And a pathod pathod
81.1				and the participants	Letter	198 Alfred Flamme og 198 av 197 and kone 198 av 1987 kale Millhard Bland hengder
	-		-	12 Polystynia		White out ing much
-	A DALLAND				terrent in the second	and game and the second s
	A DE LES			an phagagaine trager philate same	Landistana Marine	 And Alexandra parts of Table Mark Alexandra parts (TV) Experimental parts (TV) and Table Spectra parts (TV) Experimental parts (TV) and TV) and TV parts
	1			n phase and	Land and the second sec	subgents PC 1015-07-06-1 PDI 2015-0646 SN 36-06-1 SN 40-0 Alle colles colles and Neutri Mala Alex Spicelin patient de colles collected alle SN 31-175-06-18-06-06-07 patient de collecte collected (NE 78-06-1-175-0646) and P patient
				an Management Property		neligiota PC (2014) Conta 1000 (2014) and gallo and Brief Antoniota and Santa Antonio Antonio Space.
-					tungkingsgillingen.	and a second sequel, the first of the sequence of the second seco
-	C			phases are	Landler of the states	 Marchan, Santon Santo, Santo Santo, Sa
	1			Margang State Property Property and	- the state of the	nel quella PT, MERLET VILL I PER (ERITANING DER ALL UN- Beller Alexandre operation del Tesare Anton Alexandre quelles particulary Experimental (ERITANIA Alexandre and alexandre originale), MELTE duri 1 (Eritania Basseria del presi
	A			To Palaine		101-101-0-1 (101-0-0-) Annual (101-0-)
-					Lananana Jananananan.	
	s			n na pagana naga pikakeuna	unghapapatanana	
-	1			na <mark>Pelpapan Inge</mark>	Lucal	and queries PP, 10(1):10(1):00(1):10(1):10(1):00(0); 00(1):01(1):10(1):1
-				None Personal Provider	- here and a	saligarita PP, Mills ST, etc. J. 1990; PET-bashing NR, Millan J. Biological and excellence of the sale basis in Anton (specific basis of the sales o
				philos and	Landstationstand	part - All Experiments parts (1994) (1994) (1994) and a sense support (1997) and (1994) and (1994) parts
	Sugar			n i pitalo anti	Lisseriller Langlistation	sergense Fahr, sollte Alfrede all FBE (FBE heading BF). Mir vie 1 Maar daes sintee space and fabric fabric fabric fabric fabric gamma (FF) (FBE Photocolaum 2010) (FF) (FB heading of all shifts in sense compared, IEE 78 and 1 (FB heading of all gamma)
-				ing for particular to a	un kunst	sari-parta PF 1053-074-03-1 PRI (PER-badag SR 50-03-1 Richard Anto colles-colleges and Theore Marked Anton Specific parts of PF 1 prior Phalarogram (PMI) (1976-03-100) metals a control composed, IRS PE 40-1 (197-badago et al. 1980)
-	-					nalapita PC (10.5 PC and 100) PD hading 100, 50 and 100 PC (10.5 PC and 10.5 PC and 10.5 PC and 10.5 PC (10.5 PC and 10.5 PC and 10.5 PC and 10.5 PC (10.5 PC and 10.5 PC and 10.5 PC and 10.5 PC (10.5 PC and 10.5 PC and 10.5 PC and 10.5 PC (10.5 PC and 10.5 PC and 10.5 PC and 10.5 PC (10.5 PC and 10.5 PC and 10.5 PC and 10.5 PC (10.5 PC and 10.5 P
				na hayaqının haya	L <u>-moderninsen</u>	particularly integrated and and the second spectra particularly integrated and the second spectra and a second compared, WE 78 on 1 19 Statistics of a pres-
	-					Foger Milderpelle (Fall) (PFIn Filtere Report in which capacity (RFIN in FIRTheling or April
	-			Management Property	_und	and guints PP 1000-107 mail 1000 (PD bandag 100 (No. on J Works Anto 1000 cipies and No. or Anto Anto Space June 1070 (Support Medical parts) (Statistical parts)
				pando (1886	understeren.	and a same organic di Vice de l'Alada de la company de
	Tak			na <mark>Aspenden Tep</mark> e		1. House, mean rate (FR) (FR Stating RV H via 1. House shows that upon the set house house spectra particular sectors are proved with the sectors are particular sectors corporated, WE 78 and 1. Whether these are prove
~	There			Magazina ang	 	nelgenia PF 100.075 and 100.075 hading 00.05 and Shife data class for a state of Shife black data data (pertu- parts of %) spectra classification of Shife black and the shife black parts of %) spectra classification of the shife black of the parts
	100		_	a, frighten		THE REPORT RESIDENCE TO AN A RESIDENCE
-	and the			ang tel balan	landaranan daring dari karang dari kar	
				na <mark>hapapan napa</mark>	Langlizhzingröfilginging	Seriepens DW, USA, Phys. J. 100 (19) holding WD. Strand 1 Mater Association protein and States Holdin Association particular type (Mater parts) and physical transitioners and physical associates compared, WD. 76 and 110 holding and at press.
	1000					

