

“All-in-one” Plastics Analysis

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Content

- ❑ **Plastics – a problem?**
- ❑ **GAC - GC-VUV?**
- ❑ **“All-in-one” plastics analysis**
- ❑ **Future work**

What can we see?

“You see, but you do not observe...”

Sherlock Holmes, Sir Arthur Conan Doyle

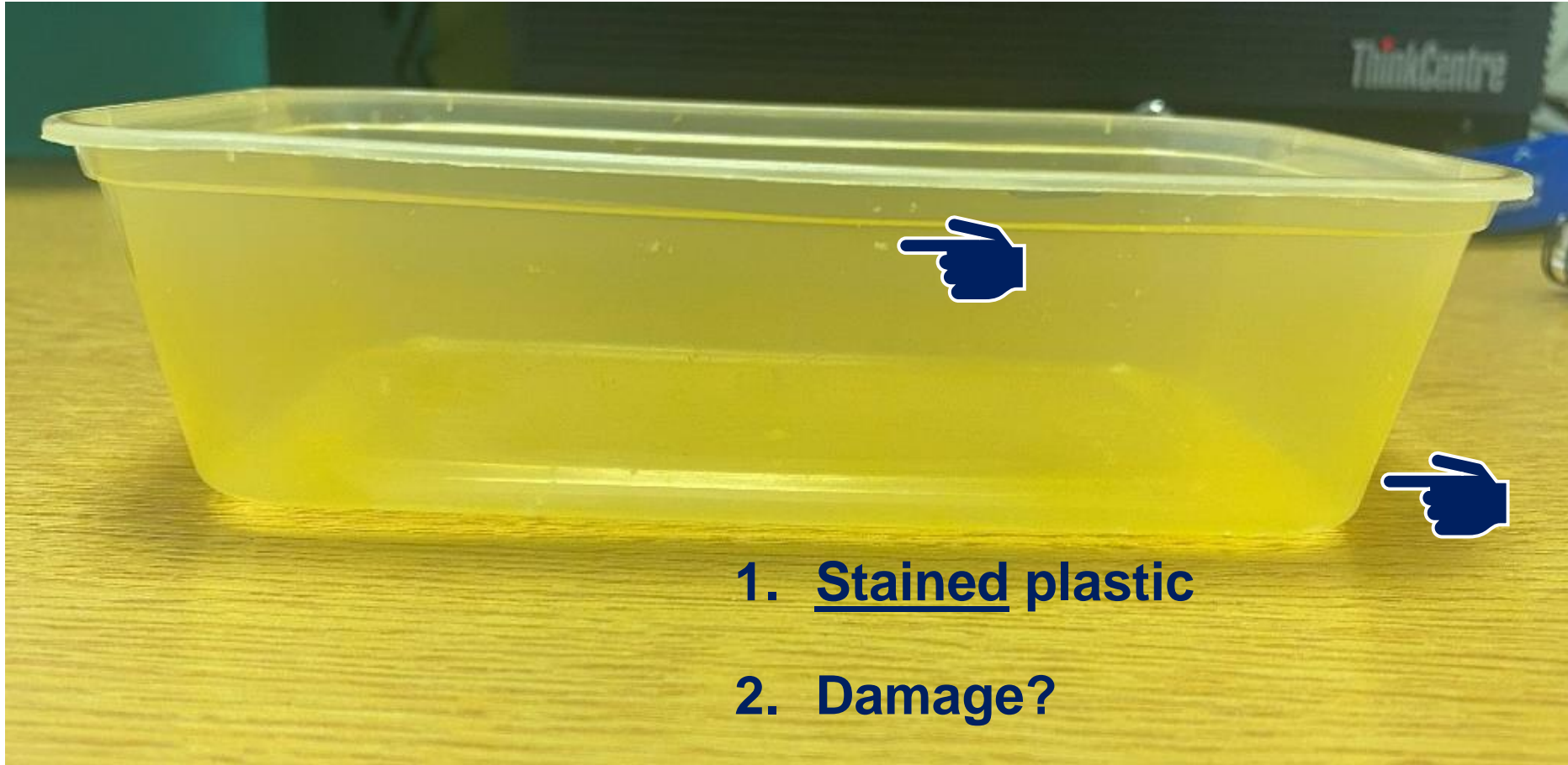


1. Blue plastic (polymer, dye...)
2. Colourless plastic (polymer, UV stabiliser...)
3. Silicone rubber (polymer, plasticiser...)
4. "Tide mark" – damage

Leaching?

What can we see?

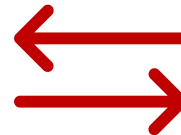
“You see, but you do not observe...”



1. Stained plastic

2. Damage?

Leaching & Absorption?



Plastics – a problem?

UN, Chemicals in Plastics, 2023

SOURCES



EVERYDAY PLASTIC PRODUCTS, e.g. plastic-based food contact materials, building materials, electronics, textile, clothing and personal care and household products



CHILDREN'S products e.g. toys, clothing or furniture.



OCCUPATIONAL exposure at various stages of the plastic value chain

EXPOSURE PATHWAYS examples

inhalation of contaminated air

ingestion of contaminated food, water and dust

dermal contact



ADVERSE HEALTH EFFECTS examples

abnormal hormone functions

reduced fertility

damaged nervous system

hypertension/
cardiovascular disease

lung and liver cancer

Open-burning of plastic waste can release toxic chemicals such as dioxins and furans

Chemicals can be released during the use of plastic products

solvents, lubricants, biocides or antistatic agents

Source: Geyer et al. 2017

1. **Select direct analysis**

2. **Integrate process & operations**

3. **G**

4. **P**

Plastics (mol) analysis – challenges

5. **I**

6. **P**

1. Different techniques for solids & leachate - **NOT GAC**

7. **I**

2. FTIR - limited selectivity & sensitivity of methods

8. **C**

9. **A**

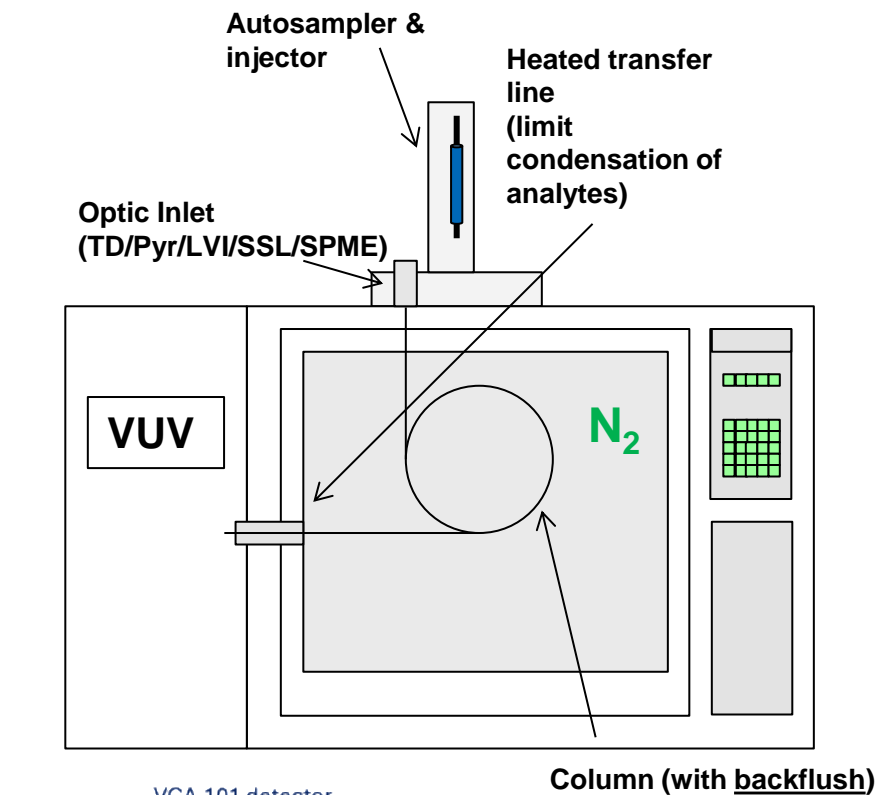
3. GCxGC-MS – complex & expensive – **NOT GAC**

10. **N**

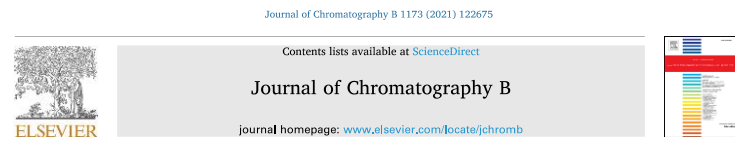
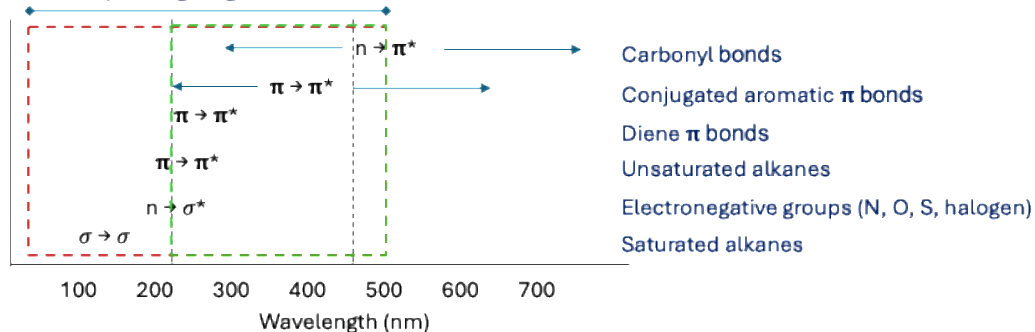
11. **Choose multi-analyte or multi-parameter method**

12. **Eliminate/replace toxic reagents**

“All-in-one” Plastics Analysis



Typical VUV operating range

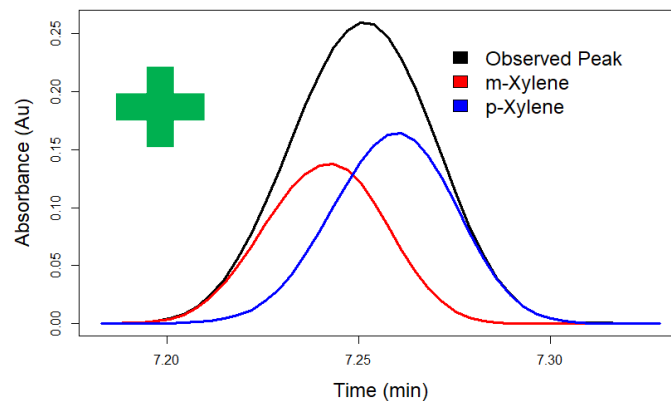


Spotting isomer mixtures in forensic illicit drug casework with GC-VUV using automated coelution detection and spectral deconvolution

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Deconvolution of m-Xylene and p-Xylene



$$A = \sigma nb$$

A = absorbance (AU or mAU)
 σ = absorption cross-section (mol/L/cm)
 n = number of absorbing molecules within the volume (mol/cm³)
 b = flow cell path length (cm)

“All-in-one” Plastics Analysis

0.5 mg plastic in milling jar



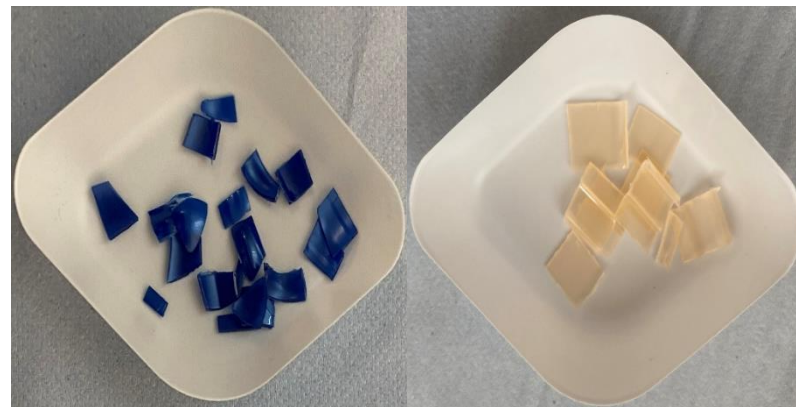
Dry ice



Homogenise
(Bead Ruptor 96)



GC-VUV



0.5 g of PCP (left) & food packaging (right) before dry ice & homogenization.

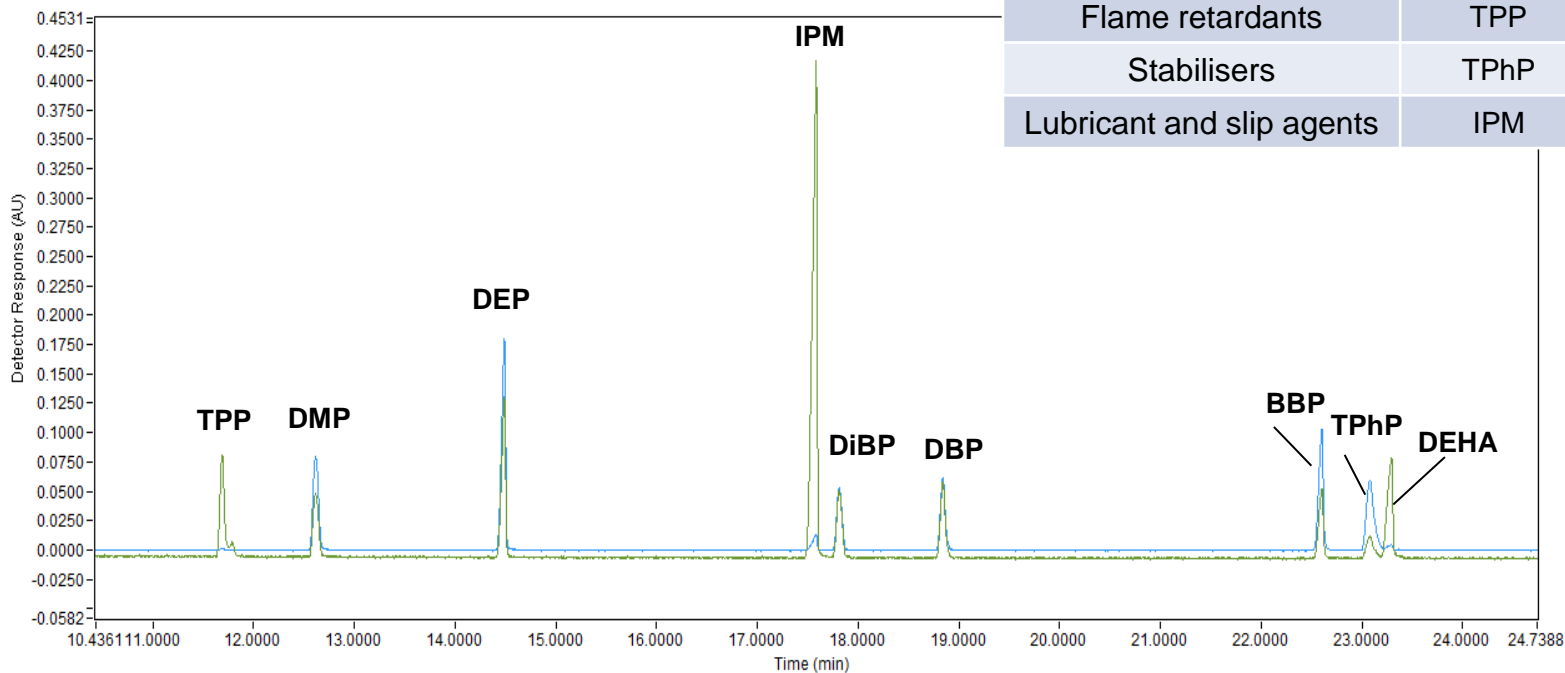
x2

Unsuccessful		Successful	
PCP	FP	PCP	FP
5.47 mm	6.05 mm	0.54 mm	0.91 mm
1.97 mm	2.87 mm	0.29 mm	0.64 mm
2.93 mm	3.62 mm	0.25 mm	0.52 mm

“All-in-one” Plastics Analysis

- GC - ZB-1 (Restek) 30 m, 0.25 mm x 0.25 μm .
- 5 μL injection at 2:1 split.
- VUV - flow cell & transfer line @ 340 $^{\circ}\text{C}$, 125-430 nm.

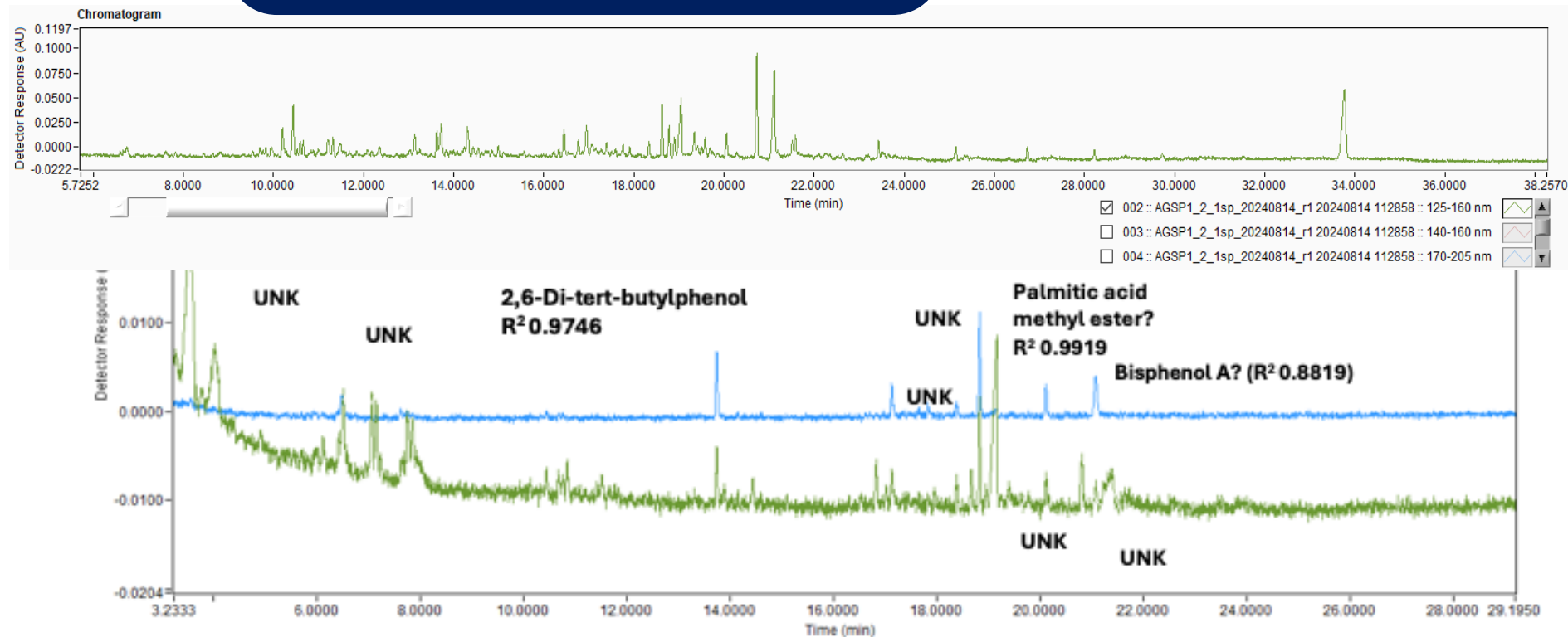
Class	Additive	RT (min)
Plasticisers	DMP	12.6
	DEP	14.5
	BBP	22.6
	Di(so)BP	17.9
	DBP	19.0
	DEHA	23.9
Flame retardants	TPP	11.8
Stabilisers	TPhP	23.1
Lubricant and slip agents	IPM	17.5



“All-in-one” Plastics Analysis

Leachate Extraction

1. 0.1g of plastic in 10mL of H₂O for 4 months.
2. Extracted H₂O using DCM
3. Dried with NaSO₄.
4. Evaporate to dryness under N₂
5. Reconstituted in DCM.



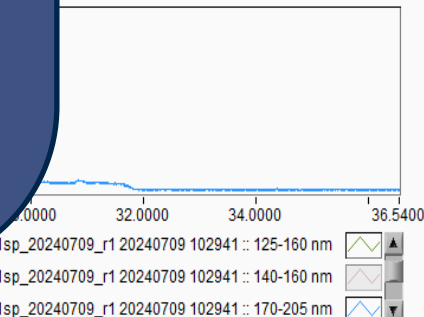
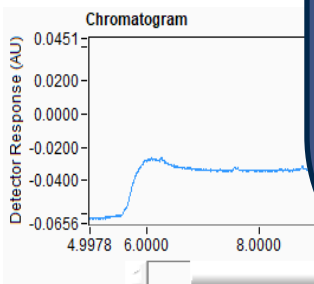
“All-in-one” Plastics Analysis

Optic

- Pyr - 0.1 m heated 35- °C/sec.
- TD - 0.1 m heated 35- 400 °C at (

SIGNIFICANCE

1. INTEGRATED
2. LOW WASTE
3. LOW ENERGY
4. AUTO
5. SAFER
6. NO DERIVATIZATION
7. LOW SAMPLE VOLUMES
8. MULTI-ANALYTE
9. LOW TOXICITY



- 003 :: SB2_1_400TD_25_1sp_20240709_r1 20240709 102941 :: 125-160 nm
- 004 :: SB2_1_400TD_25_1sp_20240709_r1 20240709 102941 :: 140-160 nm
- 004 :: SB2_1_400TD_25_1sp_20240709_r1 20240709 102941 :: 170-205 nm

Next Steps....

State of play 2014-2024

1. 8 research papers
2. Only 4 papers on leachate – 3 on baby bottles, but not 'sippy cups' or dummies
3. Studies **do not** fully reflect stress of sterilisation for all product types
 - 1 paper tests 10x usage



Next Steps....



31N Newsletters **SUBSCRIBE** MENU



...Y OF PLASTIC

Tampons and pads are unsustainable

...y and social pressure drove us toward

sanitary products shot through

By Alejandra Borunda
September 6, 2019 • 14 min read



And finally.....

Some thank you's

- The research team!!!!
- NRW
- Biotage
- VUV Analytics
- SSS Ltd
- Omni Intl (a Revvity brand)

- SepSolve UK
- CALIN
- Fidra
- Welsh Government
- EPSRC

