1.2 Constituents of polymers (2) – Detection of polymer constituents – Beilstein test

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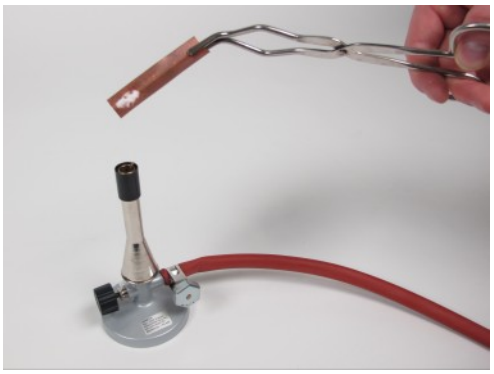
interTESS (Version 13.12 B214, Export 2000)

Task

Task

Which elements, other than carbon and hydrogen, can be contained in polymers?

Examine plastics for the presence of known elements.



Use the space below for your own notes.

Logged in as a teacher you will find a button below for additional information.

Additional information

Learning objectives

- Polymers decompose when heated.
- In decomposition products of some plastics the presence of carbon and hydrogen, in addition to oxygen and chlorine, can be detected.

Notes on set-up and procedure

Other natural polymers can be used for this experiment. As a rule, plastics do not give water off on dry distillation.

Hazard and Precautionary statements

Copper(II)-sulphate anhydrous:

H302:	Harmful if swallowed.
H315:	Causes skin irritation.
H319:	Causes serious eye irritation.
P273:	Avoid release to the environment.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P302 + P352:	IF ON SKIN: Wash with plenty of soap and water.
P309 + P310:	IF exposed or if you feel unwell: Immediately call a POISON CENTER or doctor/physician
P501:	Dispose of contents/container in accordance with applicable local, regional, national, and/or international regulations.

Remarks on the students' experiments

Since hydrogen chloride is formed during the decomposition of PVC powder, the experiment should be carried out under the hood. This is also recommended for the first part of the experiment because of the odour nuisance.

Hazard!

- Unpleasant-smelling gases which are harmful to health are evolved on heating!
- Carry out the experiment in a fume cupboard whenever possible!
- Wear protective glasses!

Notes

Nitrogen, sulphur, phosphorous, elements found most of all in natural polymers, can be identified in a similar way by means of standard detection methods (Hepar test).

Remarks on the method

It is assumed that the students already know the test for water detection by means of copper sulphate and the Beilstein test. If necessary, introduce them in a demonstration experiment.

Waste disposal

- The plastic remains can be treated as normal waste.
- The copper sheets can be collected to be further used after having been cleaned.
- Remove mechanically remaining decomposition products from the test tubes or by annealing them.

Material

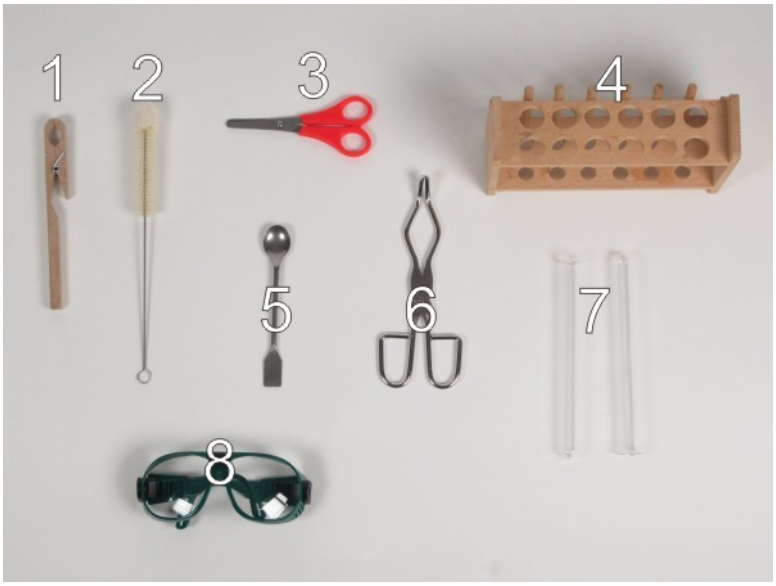
Material from "TESS Chemistry Set Polymer Chemistry" (Order No. 15305-88)

Position No.	Material	Order No.	Quantity
1	Test tube holder, up to *d* = 22 mm	38823-00	1
2	Test tube brush with wool tip, *d* = 25 mm, *l* = 270 mm	38762-00	1
3	Scissors, straight/blunt points, *l* = 110 mm	64616-00	1
4	Test tube rack for 12 tubes; *d* = 22 mm, wood	37686-10	1
5	Spoon, special steel, *l* = 150 mm	33398-00	1
6	Crucible tongs, stainless steel, *l* = 200 mm	33600-00	1
6	Test tube, *d* = 18 mm,*l* = 18 cm, 100 pcs	37658-10	(2)
8	Protective glasses, clear glass	39316-00	1

Chemicals, additional material

Position No.	Material	Order No.	Quantity
	Bunsen burner DIN, natural gas	32165-05	1
	Safety gas tubing, DVGW, sold be meter	39281-10	1
	D(+)-glucose, 1-hydr., 250 g	30237-25	
	Sample set for study of plastics, 60 pcs. of each species	31730-00	
	Polyvinyl chloride, powder, 250 g	31745-25	
	Copper foil, *d* = 0.01 mm, 100 g	30117-10	
	Copper(II)-sulphate, anhydr., 250 g	31495-25	

Material required for the experiment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Set-up

Hazards

- Unpleasant-smelling gases which are harmful to health are evolved on heating!
- Carry out the experiment in a fume cupboard whenever possible!
- Wear protective glasses!

Action

Procedure

Put a spoonful of glucose in the test tube (Fig. 1). Heat it carefully in a non-luminous (blue) flame till the glucose starts to decompose (Fig. 2).

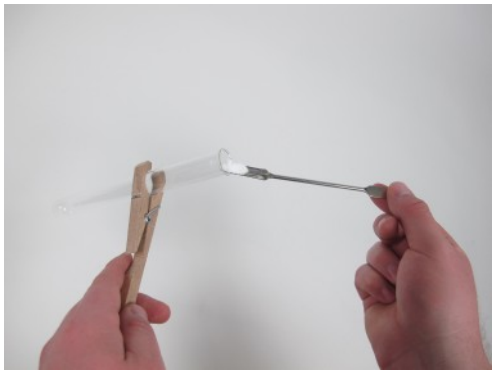

Fig. 1

Fig. 2

Then add to the precipitating droplets a spatula tip with anhydrous copper sulphate (Fig. 3).

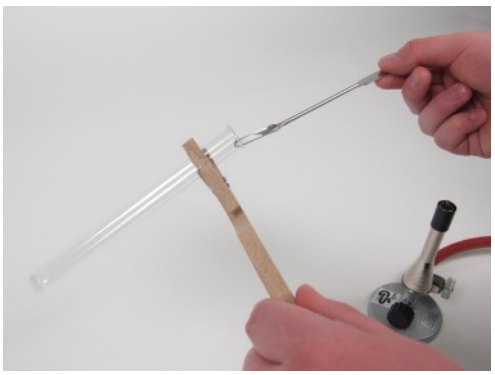

Fig. 3

Repeat this procedure with small pieces of polymethyl methacrylate.

Cut from the copper foil a stripe (approximately 2 cm wide and 8 cm long). Fold it in the middle, so that a groove is formed. Take it at one ending by means of the crucible tongs and hold it above the non-luminous burner flame until its coloration is no longer shown (Fig. 4).

Fig. 4

Let the copper stripe cool down for a while, then put a spatula tip with polyvinyl chloride powder onto it. Hold the copper stripe once more on the flame, so that the polymer powder on the strip is also heated (Fig. 5).

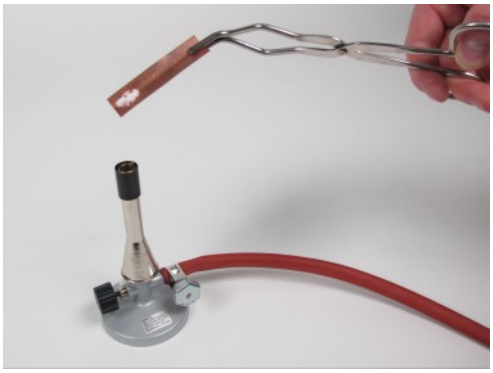

Fig. 5

Waste disposal

- The plastic remains can be treated as normal waste.
- The copper sheets can be collected and further used after having been cleaned.

Evaluation

Observation 1a:

Write down your observations in general form.

Glucose/Polymethyl methacrylate (PMMA):

Both substances decompose on heating, whereby they blacken and unpleasently smelling gases evolve. Droplets precipitate in the cold part of the test tube. If anhydrous copper sulphate is added to them, it turns blue.

Observation 1b:

Polyvinyl chloride:

The polyvinil chloride decomposes by heating it on the copper foil. The burner flame clearly shows a green edge.

Questions and exercises

Question 1a:

Draw the conclusions from your observations.

a) Glucose/Polymethyl methacrylate:

Since copper sulphate turns blue, the droplets must therefore be water. The polymers decompose while forming water.

Question 1b:

Polyvinyl chloride:

Since the copper foil does not change its colour after having been annealed, the PVC powder must contain a substance, which together with copper, dyes the flame to green.

Question 2a:

Wich elements were detected in this experiment

a) Glucose/Polymethyl methacrylate (PMMA):

Since during this experiment water is formed, hydrogen and oxygen must be contained in both polymers.

Question 2b:

Polyvinyl chloride:

Copper halides dye the flame green. The PVC powder must therefore contain a halogen (chlorine).

Question 3:

Which further elements can be contained in plastics?