Thermoplastics and duroplastics (Item No.: P7182200)

Curricular Relevance

Area of Expertise: Chemie

Education Level: Klasse 10-13

Topic: Organische Chemie

Subtopic: Polymerchemie

Experiment: Thermoplaste - Duroplaste

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	20 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

polymers, thermoplastics, duroplastics

Task and equipment

Information for teachers

Learning objectives

- Generally, plastics can be divided into two classes: thermoplastics and thermosets or duroplastics (and elastomers), which show a different behaviour due to their different molecular structures especially when heated.
- Because of the threadlike structure of thermoplastics (which can be "frozen" when heated and afterwards quenched), they show a "memory-effect" when re-heated and they take their original shape again.

Notes on set-up and procedure

In order to save valuable time provide the students with precast tube pieces. Broomstick pieces are well suited as wooden rollers.

Hazards

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

Remarks on the students' experiments

Make sure that the respective plastics are not heated too much. The temperature regulation can be achieved by adjusting the burner flame or by appropriate adjustment of the height of the support ring. On no account should the burner flame reach the plastic materials. Press firmly the edges of the heated Polyethylene pieces while welding them.

Notes

Plastics have a largely amorphous so-called glassy state in which they are hard and hardly malleable. They can be differentiated by their behaviour on heating. At very low temperature elastomers take a glassy state, at room temperature they have rubber-like elastic properties. Thermoplastics are hard at room temperature, they also have a softening (melting) range which goes over into a fluid range. Duroplasts go over from the glassy state directly to a decomposition state, they have neither softening nor flow range. Intermediate states can be formed from semi-crystalline structures, etc.

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Remarks on the method

This experiment goes back to the experiments on plastic properties, therefore some knowledge thereof is assumed for the evaluation. However, the subsequent thermal return into a tube is only possible with an exact control of temperature.

Waste disposal

- Dispose of plastic rods in the normal waste.
- Reuse PVC pieces for similar experiments.

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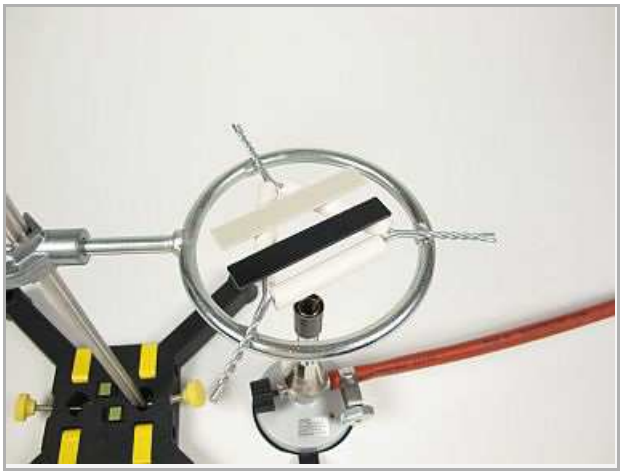
Task and equipment

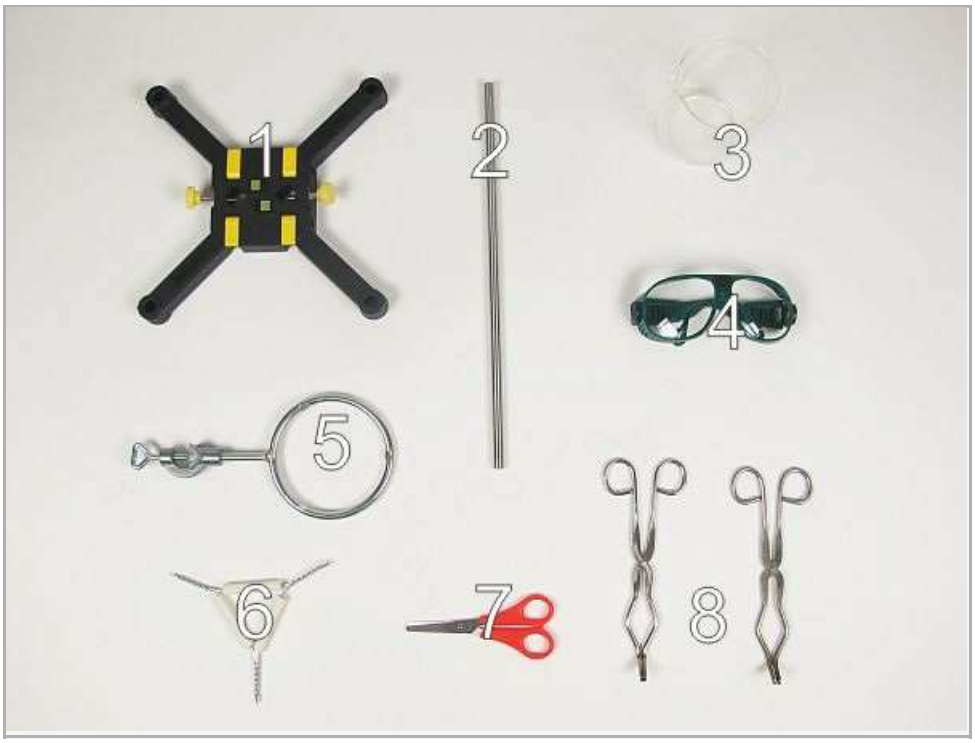
Task

What are the differences between thermoplastics and duroplastics?

Examine the behaviour of duroplastics and thermoplastics when heated.



Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
3	Glass beaker DURAN®, short, 400 ml	36014-00	1
4	Protecting glasses, clear glass	39316-00	1
5	Ring with boss head, i. d. = 10 cm	37701-01	1
6	Triangle w.pipeclay, l 50mm	33277-00	1
7	Scissors, l = 110 mm, straight, point blunt	64616-00	1
8	Crucible tongs,200mm,stainl.steel	33600-00	2
	Protective desk plate 40 x 40 cm	39180-10	1
	Butane catridge CV 300 Plus, 240 g	47538-01	1
	Butane burner f.cartridge 270+470	47536-00	1
	Zinc, sheet 250x125x0.5 mm, 200 g	30245-20	1
	Sample set for study of plastics, 60 pcs. of each species	31730-00	1
	PVC-plates,pack.5 pcs.	31751-02	1
	PVC tubing, i.d.19mm	39293-00	

Set-up and procedure

Set-up

Hazards

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

Set-up

Set up the support system according to Fig. 1 - Fig. 4. Put the pipeclay triangle on the support ring. Place the burner under the support ring. Adjust the height of the support ring in such a way that the tip of the flame is about 10 cm below it.

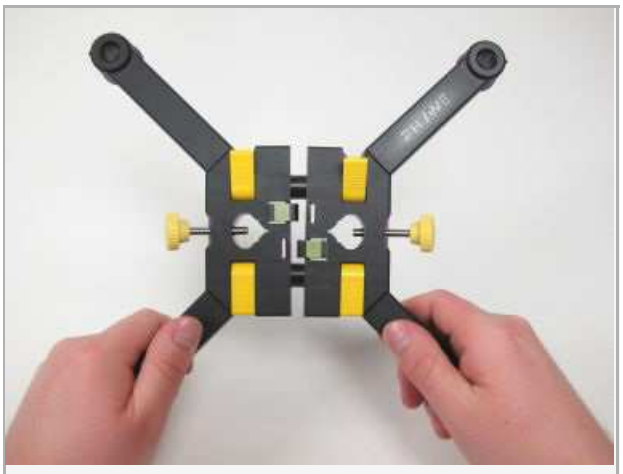


Fig. 1

Fig. 2

Fig. 3

Fig. 4

Procedure

Procedure

Put the two plastic strips onto the pipeclay triangle and heat it with a burner (Fig. 5). By means of the crucible tongs check the softening and flexibility of the sticks again and again.

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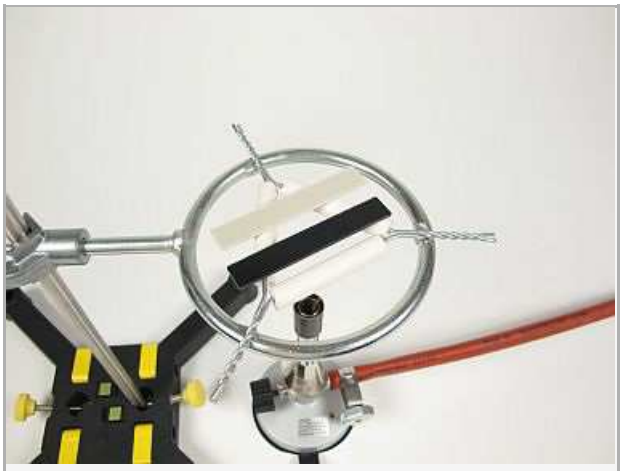

Fig. 5

Try to pull apart the sticks as soon as a significant softening is determined (Fig. 6). Heat the expanded parts of the rods once more and try to weld their free ends. Heat then the rods until an initial decomposition state occurs, then finish this part of the experiment.

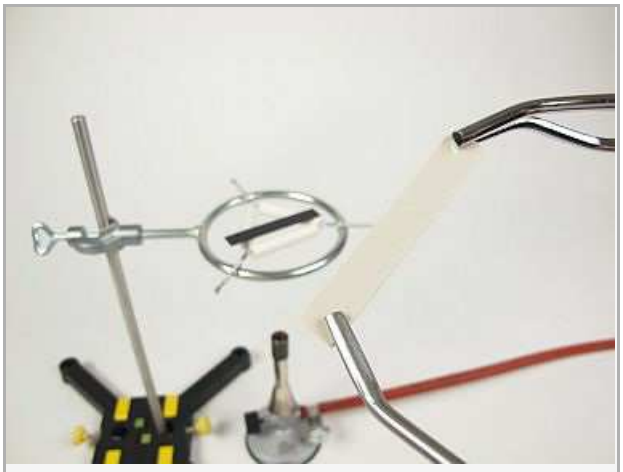

Fig. 6

Remove the pipeclay triangle, put an aluminium plate on the support ring. Cut a 10 cm long and 3 cm wide piece from the PVC plate. Place it on the heated aluminium plate, and continue heating it carefully with the burner (Fig. 7).
Turn many times the PVC strips until it softens significantly and turns malleable (Fig. 8). The PVC strips should show no decomposition. To this end regulate the temperature adjusting the support ring accordingly.

Fig. 7

Fig. 8

Wrap the softened strips around the wooden roller and quench them in ice water (Fig. 9). Cut the PVC-tubing alongside (Fig. 10).

Remove the PVC-tube from the wooden roller and dry it, and then put it as well as the PVC-tubing on the aluminium plate and warm them carefully once more (Fig. 11).

Fig. 9

Fig. 10

Fig. 11

Waste disposal

Dispose of plastic rods in the normal waste. Reuse PVC pieces for similar experiments.

Report: Thermoplastics and duroplastics

Result - Observation 1

Write down your observations of the first part of the experiment in general form.

a) Polyester resin rods:

b) Polyethylene rods:

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Result - Observation 2

Write down your observations of the second part of the experiment in general form.

a) PVC-strip

b) PVC-tubing

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Evaluation - Question 1

Draw the conclusions from your observations, in this context assign the different plastic materials to Duroplasts and Thermoplastics, and explain the reasons for the different behaviour of these groups.

a) 1st part of the experiment:

b) 2nd part of the experiment:

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Evaluation - Question 2

Why do not Duroplasts show a "memory-effect"?

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