Polymerization reactions (1) - Formation of polystyrene (Item No.: P7181000)

Curricular Relevance

Area of Expertise: Chemie
Education Level: Klasse 10-13
Topic: Organische Chemie
Subtopic: Polymerchemie
Experiment: Polymerisationsreaktio (1) - Polystyrolbildung

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

polystyrene, polymerization

Task and procedure

Information for teachers

Learning objectives

- Styrene can be polymerized under suitable conditions.
- The resulting plastic is hard, glassy and brittle.

Notes on set-up and procedure

Instead of benzoyl peroxide also other radical starters such as azoisobutyronitrile can be used in this experiment. Ensure that the beaker stands firmly in the sand bath. The burner flame must be adjusted so that the styrene vapours cannot be ignited.

Hazard and Precautionary statements

Styrene:

H226:	Flammable liquid and vapour.
H315:	Causes skin irritation.
H319:	Causes serious eye irritation.
H332:	Harmful if inhaled.
H400:	Very toxic to aquatic life.
P210:	Keep away from heat/sparks/open flames/hot surfaces. No smoking.
P273:	Avoid release to the environment.
P302 + P352:	IF ON SKIN: Wash with plenty of soap and water.
P304 + P340:	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

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Benzoyl peroxide:	
H241:	Heating may cause a fire or explosion.
H317:	May cause an allergic skin reaction.
H319:	Causes serious eye irritation.
P210:	Keep away from heat/sparks/open flames/hot surfaces. No smoking.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P302 + P352:	BIF ON SKIN: Wash with plenty of soap and water.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Hazards

- Avoid contact of benzyol peroxide with skin, wear protective glasses!
- Styrene vapours are highly flammable and toxic. Carry out the experiment under the hood!

Remarks on the students' experiments

Threads, which solidify becoming a glass-like substance, can be especially well pulled during the transition from viscous to solid state. The transition to the viscous state is clearly visible in the bubble formation.

Notes

The slightly toxic AIBN decomposes only at higher temperatures, hence, the reaction is slower under the given experimental conditions. The chain-starters (accelerator) decompose at higher temperatures forming radicals. The resulting radicals attack the double bonds, whereby the chain polymerization is initiated.
The first polymerizations with styrene were carried out in 1930, since 1936 polystyrene is produced in large-scale industrially. Since that moment polystyrene counts to the most widely used plastics.

Remarks on the method

The answers to the tasks 2 and 3 require the knowledge about covalent bonding. In order to answer the question 2 specific teacher's information about the structure and reaction of the initiator molecules are necessary.
A phenomenological evaluation of the experiment (production of a known plastic) is recommendable for learning groups which have not treated bond theories yet. Here is recommendable to make a connection with the experiment on "Plastics Modification (3): Production of polystyrene foam".

Waste disposal

- Remove mechanically the sticking plastic remains from the beaker.
- The plastic remains can be treated as normal waste.

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Polymerization reactions (1) - Formation of polystyrene **(Item No.: P7181000)**

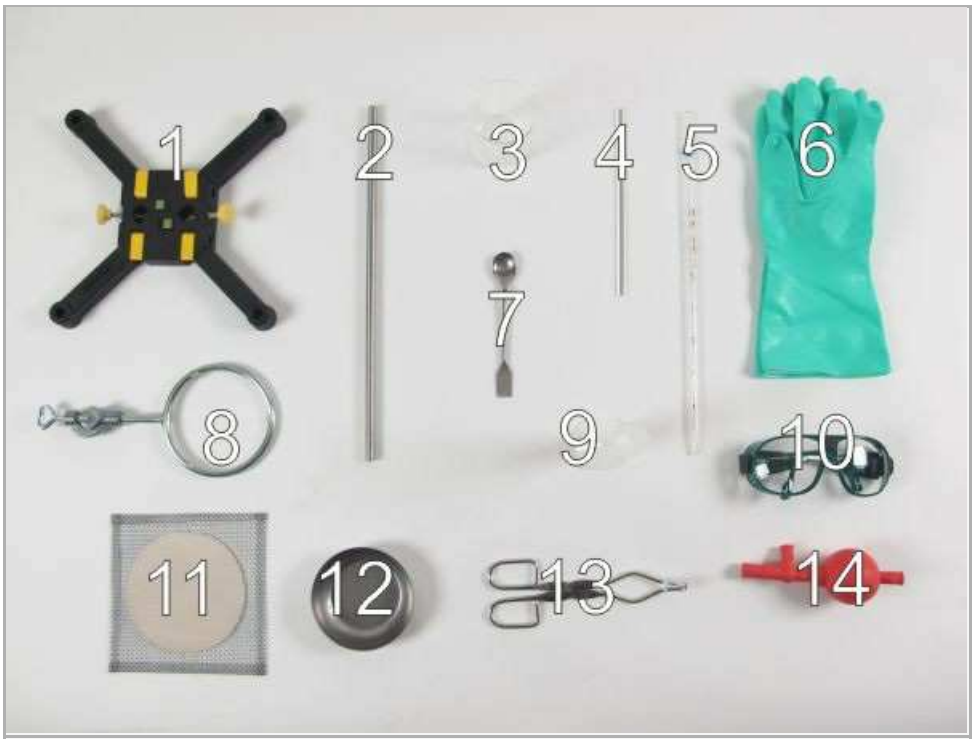
Task and procedure

Task

How can polystyrene be produced?

Polymerize styrene to polystyrene.

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, 150 ml	36012-00	1
4	Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	1
5	Graduated pipette, 5 ml	36598-00	1
6	Rubber gloves, size S (7)	39325-00	1
7	Spoon, special steel	33398-00	1
8	Ring with boss head, i. d. = 10 cm	37701-01	1
9	Grad.cylinder,high,PP,50ml	46287-01	1
10	Protecting glasses, clear glass	39316-00	1
11	Wire gauze with ceramic, 160 x 160 mm	33287-01	1
12	Iron basin, d 100 mm	33201-00	1
13	Crucible tongs,200mm,stainl.steel	33600-00	1
14	Pipettor,bulb,3 valves, 10ml max.	47127-01	1
	Butane burner f.cartridge 270+470	47536-00	1
	Butane catridge CV 300 Plus, 240 g	47538-01	1
	Styrene 250 ml	31858-25	
	Standard sand,fine 2500 g	31825-79	
	Benzoyl peroxide/25% H2O 25 g	30977-04	
	Beaker, 100 ml, low form, stackable, plastic	36081-00	
Additional material			
	Jam jar lid		
	Fume hood		

Set-up and procedure

Set-up

Hazards

- Avoid contact of benzyol peroxide with skin, wear protective glasses!
- Styrene vapours are highly flammable and toxic. Carry out the experiment under the hood!





Set-up

Set up the support system with the support ring and the gauze wire according to Fig. 1 - 5.

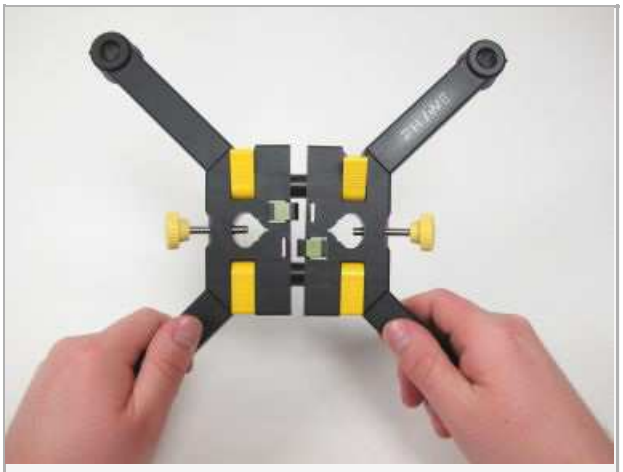


Fig. 1

Fig. 2

Fig. 3

Fig. 4

Place a Bunsen burner under the wire gauze. Adjust the height by means of the support ring so that the flame tip touches the wire gauze (Fig. 5).

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Fig. 5

Give so much sand in the iron basin that the bottom is well covered and put it on the wire gauze (Fig. 6).

Fig. 6

Place the beaker on the sand, then fill up the iron basin roughly full with sand. Make sure that the beaker stands securely (Fig. 7).

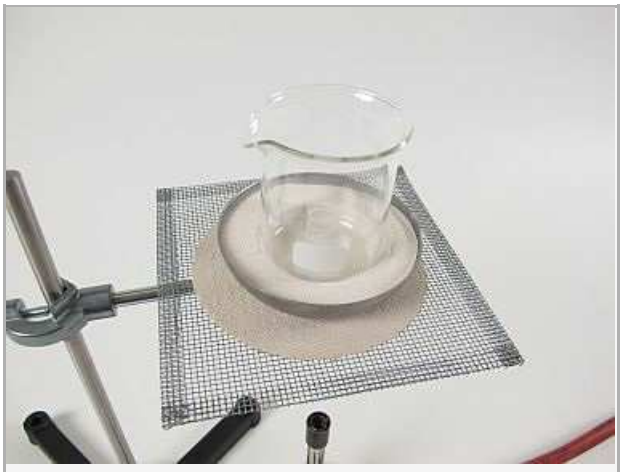

Fig. 7

Procedure

Procedure

Put 20 ml of styrene and a full spatula tip of benzoyl peroxide into the beaker (Fig. 8 - 9).

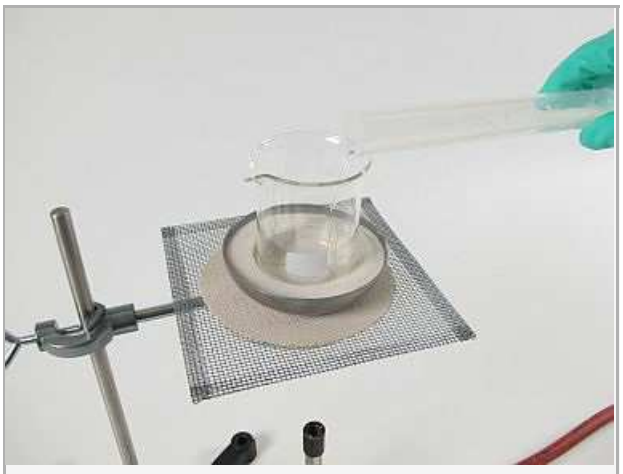
Fig. 8


Fig. 9

Stir the mixture with the glass rod until a homogeneous mixture results. While doing so hold the beaker firmly with the other hand.
Heat up the sand bath till styrene begins to boil, then adjust the burner on the lowest possible flame.
In the meantime carefully stir the mixture with the glass rod (Fig. 10).


Fig. 10

Pull threads from the mass by means of the glass rod, as soon as it becomes viscous. Pour then the content of the beaker (hold it with the crucible tongs) into the jam jar lid (Fig. 11 - 12).

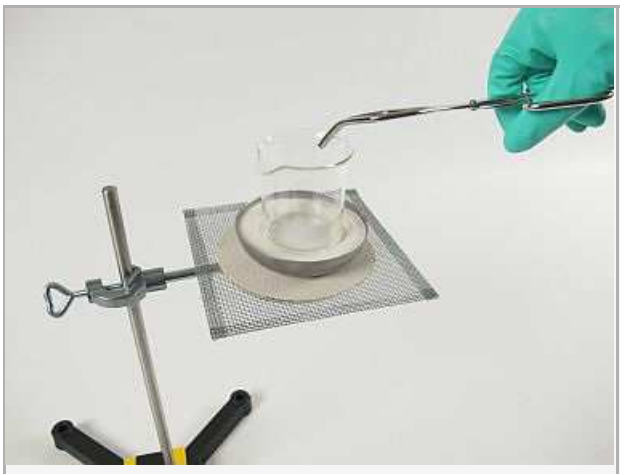

Fig. 11

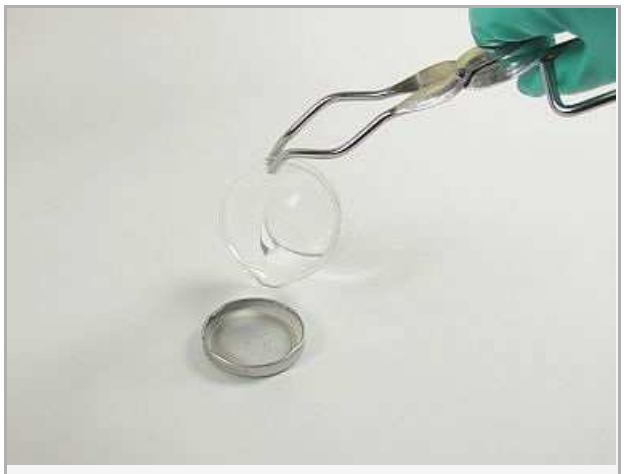

Fig. 12

Check the consistency of the substance after 3 min.

Waste disposal

- Remove mechanically the sticking plastic remains from the beaker.
- The plastic remains can be treated as normal waste.

Report: Polymerization reactions (1) - Formation of polystyrene

Result - Observations

Write down your observations in general form.

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Evaluation - Question 1

Draw the conclusions from your observations.

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Evaluation - Question 2

Explain the function of the benzoyl peroxide.

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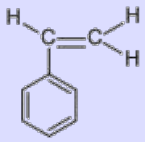
Evaluation - Question 3

Styrene has the following strucutre:



Try to formulate a statement about the reaction process on the basis of the structural formula.

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