



Plastics Topics – Identification of plastics

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Plastics Topics – Identification of plastics

Contents:

1.	Introduction.....	2
2.	The basic tests.....	2
3.	Testing.....	3
4.	Thermosetting materials.....	4
5.	Thermoplastic materials.....	5
6.	Styrene-based polymers.....	6
7.	Non-styrene based polymers.....	7
8.	Polyolefin type polymers.....	8
9.	Non-polyolefin polymers.....	9
10.	Non-polyolefin (1).....	10
11.	Non-polyolefin (2).....	11
12.	Summary.....	12

Plastics Topics – Identification of plastics

1. Introduction

When working with plastics there is often a need to identify which particular plastic material has been used for a given product. This is essential to get an idea of the cost and likely properties of the product. The identification of plastics is generally very difficult due to:

- The wide range of basic polymers that are available for use.
- The wide range of additives that can be used to modify the properties of the basic polymer.
- The wide range of mixtures or compounds of polymers that can be manufactured to get the required properties.

Despite this there are some simple tests that can be carried out to get a basic idea of the possible base polymer used for the manufacture of any given product. These tests are simple to carry out for most people and require no special equipment. These tests are a first guess only at the material type and should always be confirmed if definite answers are needed.

Note: The tests given here can be dangerous if performed improperly. Carry out all testing with care, particularly when burning or smelling plastics fumes, some fumes are dangerous! Be careful when using burning tests and carry out the tests under supervision only.

There are also some more complicated tests that can be carried out but these require some standard laboratory equipment, details of these are given in 'Simple Methods for Identification of Plastics' by Dietrich Braun (Hanser, ISBN 978-1-56990-526-5 for English text) but there is no substitute for a full analysis of the plastic.

The difference between a polymer and a plastic

A polymer is the basic long chain molecule and is the pure molecule. Polymers are rarely useful in themselves and are most often modified or compounded with additives (including colours) to form useful materials. The compounded product is generally termed a plastic. Most people have little contact with 'polymers' because most articles that they come across are actually modified and coloured and therefore are actually plastics.

Thermoplastics materials and thermosetting materials

The basic division of polymer-based materials is between 'thermoplastic materials' and 'thermosetting materials'. Thermoplastic materials can be melted many times and will harden on cooling to return to their normal state. Applying heat will soften them again.

Thermosetting materials can be shaped and hardened once only. Applying heat will not soften the material but will burn or char it.

2. The basic tests

The basic tests to apply are:

- Look at the sample.
- Feel the sample.
- Cut the sample.
- Burn some of the sample.
- Scuff the sample with a fingernail.
- See if it floats in water.

These tests will give you a fair idea of what the basic polymer is.

Note: The tests given here are not necessarily definitive and the presence of certain additives (for instance flame retardants) can significantly change the behaviour of a product.

Plastics Topics – Identification of plastics

3. Testing

Stage 1: Look at the sample

This will give you a lot of information.

The colour of the plastic will give you some information. Some polymers have restricted colour ranges, particularly the thermosetting types. Others tend to be more glossy in colour (polypropylene), whereas some are both glossy and glassy (the acrylics).

Stage 2: Feel the sample

After you have carried out the tests in this series a few times you will start to get the feel for various plastics. The polyolefins have a very distinctive feel and you can generally tell if it is one of them. The presence of glass fibre or other reinforcement materials can alter the feel and stiffness of the sample but you can sometimes tell by the feel if there is a reinforcement present.

Stage 3: Cut a thin sliver from the edge of the sample.

The first test is to cut a small sliver off the sample. This tells you a lot about the type of plastic you are trying to identify:

- Powdery chips formed - Generally a thermosetting material.
- Smooth sliver of plastic formed - Generally a thermoplastic material.

Click on the links to go to the appropriate page and possibly identify the plastic you have.

Plastics Topics – Identification of plastics

4. Thermosetting materials

Flame testing

Hold the sample in a lighted match and smell.

Note: Take care when smelling any plastic material. Make sure the flame is totally out. Do not directly inhale the fumes from the burning sample. Hold the sample away from your nose (about 20 - 30 cm) and sniff just enough to get the smell. Do not inhale deeply. Take care of any dripping polymer - it will be very hot and can burn.

Results

- Burns but is self-extinguishing. Carbolic smell present. The sample is usually black or brown:

Phenol formaldehyde resin.

- Burns but is self-extinguishing. Sharp acrid odour. The sample is light in colour:

Phenol formaldehyde epoxide resin.

- Burns with a fishy smell. Sample is usually a bright colour or white:

Urea formaldehyde or melamine formaldehyde resin.

Carry out scuff test with fingernail.

Scuff testing

Scuff the product with a fingernail.

Results

- Scuffs with fingernail:

Urea formaldehyde resin.

- Does not scuff with fingernail:

Melamine formaldehyde resin.

Plastics Topics – Identification of plastics

5. Thermoplastic materials

Drop testing

Drop the sample onto a hard surface.

Results

- 'Metallic' ringing noise generally indicates the presence of styrene-based polymer:

Styrene based polymer.

- Absence of 'metallic' ringing noise means it is not generally a styrene-based polymer (unless it is a foamed plastic, in which case the foam will be evident or it may be High Impact Polystyrene, PS-HI in which case it will have the PS type of feel to it):

Non-styrene based polymer.

Plastics Topics – Identification of plastics

6. Styrene-based polymers

Flame testing

Hold the sample in a lighted match and smell.

Note: Take care when smelling any plastic material. Make sure the flame is totally out. Do not directly inhale the fumes from the burning sample. Hold the sample away from your nose (about 20 - 30 cm) and sniff just enough to get the smell. Do not inhale deeply. Take care of any dripping polymer - it will be very hot and can burn.

Results

- Characteristic smell of polystyrene:

Polystyrene.

- Characteristic smell of polystyrene + a bitter smell:

Styrene-acrylonitrile.

- Characteristic smell of polystyrene + smell of rubber:

Acrylonitrile-butadiene-styrene copolymer.

Plastics Topics – Identification of plastics

7. Non-styrene based polymers

Float testing

Place the sample in a small bowl of water that has had some detergent added to it.

Note: you must have the detergent or surface tension will prevent the sample from behaving as it should. For foam samples this test obviously does not work!

Results

- Sample floats:

Generally a polyolefin.

- Sample sinks:

Generally a non-polyolefin.

Plastics Topics – Identification of plastics

8. Polyolefin type polymers

If the sample floats it generally indicates a polyolefin type of polymer but two more tests are needed to check what type of polyolefin it is.

Scratch testing

Scratch the sample with your fingernail.

Flame testing

Hold the sample in a lighted match and smell.

Note: Take care when smelling any plastic material. Make sure the flame is totally out. Do not directly inhale the fumes from the burning sample. Hold the sample away from your nose (about 20 - 30 cm) and sniff just enough to get the smell. Do not inhale deeply. Take care of any dripping polymer - it will be very hot and can burn.

Results

- Glossy surface, does not scratch, burns with the smell of paraffin wax:

Polypropylene.

- Glossy surface, slight scratching, burns and drips like wax:

Polyethylene (High Density).

- Not very glossy surface, scratches easily, burns with the smell of paraffin wax:

Polyethylene (Low Density).

Plastics Topics – Identification of plastics

9. Non-polyolefin polymers

If the sample sinks it generally indicates a non-polyolefin type of polymer.

Flame testing

Hold the sample in a lighted match and smell.

Note: Take care when smelling any plastic material. Make sure the flame is totally out. Do not directly inhale the fumes from the burning sample. Hold the sample away from your nose (about 20 - 30 cm) and sniff just enough to get the smell. Do not inhale deeply. Take care of any dripping polymer - it will be very hot and can burn.

Results

- Ignites, continues to burn after match removed and burns with a clear flame.
- Difficult to ignite and self-extinguishing (note the colour of the flame and how easily it starts to burn).

Plastics Topics – Identification of plastics

10. Non-polyolefin (1)

Flame testing

If the sample ignites, continues to burn after match removed and burns with a clear flame. Sniff the vapour.

Note: Take care when smelling any plastic material. Make sure the flame is totally out. Do not directly inhale the fumes from the burning sample. Hold the sample away from your nose (about 20 - 30 cm) and sniff just enough to get the smell. Do not inhale deeply. Take care of any dripping polymer - it will be very hot and can burn.

Results

- Fruity odour:

Acrylic (probably PMMA).

- Burning paper odour:

Cellulose acetate or Cellulose propionate (but no test available to differentiate between the two).

- Burns with smell of bad butter:

Cellulose acetate butyrate.

Plastics Topics – Identification of plastics

11. Non-polyolefin (2)

Flame testing

If the sample is difficult to ignite and self-extinguishing then note the colour of the flame and how easily it starts to burn.

Note: Take care when smelling any plastic material. Make sure the flame is totally out. Do not directly inhale the fumes from the burning sample. Hold the sample away from your nose (about 20 - 30 cm) and sniff just enough to get the smell. Do not inhale deeply. Take care of any dripping polymer - it will be very hot and can burn.

Results

- Sample burns with a green flame:

- Acrid smell, material is soft and flexible

Plasticised Poly(vinyl chloride).

- Acrid smell, material is stiff and glossy:

Unplastised Poly(vinyl chloride).

- Sample burns with a yellow flame:

- Smell of formaldehyde:

Polyacetal.

- No real smell, sample has slippery feel. Push cold metal point onto hot surface and withdraw, if threads of material are formed:

Polyamide (Nylon).

- No real flame formed, material forms a cellular structure and then decomposes:

Polycarbonate.

Plastics Topics – Identification of plastics

12. Summary

The testing carried out should have given a possible result for your sample. Naturally we cannot always identify the given material from a series of such simple tests but with experience you ought to be able to get about 95% of the plastics identified.

We hope you found this simple guide useful.

Please contact Tangram Technology Ltd. if you need any additional information.

Return to the start.