Investigation of a Manufactured Article

Cigarette Lighter

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This is part of a set of resources on the topic.

- Powerpoint summary
- Supervisor Guide
  - For teaching assistants or instructors giving a background and answers to likely student questions.
- For Students
  - MiniProject - Investigation of a manufactured article
    - Explaining the project
  - Instructions for Dismantling
    - How to do this safely
  - Data Booklet
    - With lab test data for reference
  - Materials Selection for a Lighter
    - Instructions on materials selection methodology and how to use CES EduPack.

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Investigation of a Manufactured Article

1. Introduction

This Assessed Practical is based on a systematic investigation of a manufactured article, specifically a Ronson butane-gas lighter made in China. As you work through it you will discover how the lighter works in detail, you will identify the materials used for some of the components and you will need to consider why those materials were chosen. Many of the necessary scientific principles and basic facts have been covered in the course, but you are welcome to look for more information in libraries (College or Departmental) and by computer searches. Keep in mind that the "factory-door" cost of the lighter is about 15 pence.

You will be able to work on your project for two practical sessions, this one and **again in the same Department** in a week's time. You will also need to spend some time outside the practical sessions preparing your report.

During the practical sessions, please work in pairs. Each pair will be given one lighter which has been de-gassed, and several working lighters will be available. After working through the information referred to in section 4 below, each pair will dismantle their de-gassed lighter. Then, using information provided, **each of you** will deal with the identification of the materials used for a few components specified in section 5. **Writing your report must also be done individually.** Advice about the form of the report is given in section 7. Reports are to be submitted at your practical session one week after your second practical session on the project.

2. Learning Outcome

On completion of the practical sessions and the writing of your report, you will have a fuller understanding of how some of the scientific principles and experimental techniques covered so far in the Materials & Mineral Sciences course underpin the selection and use of materials in engineering practice.

3. Schedule

N.B. Do *not* start work on the lighter until you have read the sections below!

Session 1

- Operate a working lighter.
- After watching the *introductory video* and reading the instruction sheet, dismantle an empty lighter, working in pairs, and work out the mechanical and electrical operation.
- Make preliminary notes of ideas for further investigation, about how you think the specified components were made, and about the choices of material.

Session 2

- Identify the materials used for the components specified in section 5.

4. Dismantling the lighter

In order to see how the lighter works and to avoid damaging components so far as possible and, above all, to ensure that you work ***safely***, it is essential to adhere to the following procedure. First, before attempting to dismantle the lighter, check carefully that it has been drained of butane, and watch the *introductory video*. After that, dismantle the lighter, keeping a careful note of the relationship between components and referring, whenever necessary, to the exploded view supplied on a separate sheet and which shows the components, each identified by a number, and a list relating each number to the name of the component. (Some of the names may seem a little strange but they are the manufacturer's choice.) Large-scale colour prints are also on display in the laboratory showing (a) the components from a dismantled lighter, (b) a cross-section of a complete lighter, (c) a section through the electronic assembly. In case of difficulty, consult a demonstrator.

5. Components to be studied

The components to be studied in detail are:

No.	Description	Material	Data, etc. provided*
28	piezo unit	ceramic	X-ray diffraction trace, EDS data
6	nozzle bottom	metallic	metallographic sample (red mount), EDS data
24	hammer	metallic	metallographic sample (green mount), EDS data
29	back mass	metallic	metallographic sample (black mount), EDS data
10	wick	polymeric	IR spectrum, SEM pictures, property data
32	bracket	polymeric	IR spectrum, property data
37	pole base	polymeric	IR spectrum, property data

EDS = energy dispersive spectroscopy
IR = infra-red spectroscopy
SEM = scanning electron microscopy

You may feel unfamiliar with the broad principles of some of these techniques and of what they can reveal about materials. Please do not worry but do ask a demonstrator.

* Reference data available include a set of IR spectra of common organic polymers. The EDS data provide information about the chemical composition of the metallic samples. The X-ray diffraction traces also indicate the sequence of *d*-spacings for likely ceramics.

6. Identification of materials used

The following summarises the approaches that are recommended for the identification of the materials used in the subset of components listed in section 5. The use of software such as Cambridge Engineering Selector, CES, can substantially aid materials selection although is outside the immediate scope of the current project. Nonetheless, the use of CES has been included in the video and also in the additional two handouts (available on the web):

- IA Artefact project - use of CES
- Selecting materials for the lighter tank using CES

The software itself can be downloaded for use on PCs (or Macs with a PC emulator) from:

www.msm.cam.ac.uk/Teaching/ces/index.html

CES also includes good and concise descriptions of fabrication techniques, as is explained in the first of the two handouts. You may find these useful in explaining how the materials identified have been made into the different components, or even why the materials have been used.

6.1 Metallic components

For each metallic component:

- use the EDS data to decide what metal or alloy has been used;
- look at one of the mounted sections under a reflected light microscope, choose a suitable magnification, check whether the microstructure varies from region to region (this may give clues about the manufacturing process used), for alloys try to estimate the composition, make an annotated sketch of a representative region;
- consider why that metal/alloy was chosen and how the component may have been made from the starting metal or alloy.

6.2 Polymeric components

For each polymeric component:

- use the IR spectra in conjunction with the reference IR spectra to decide which polymers have been used;
- for the wick (component 10) look at the SEM pictures;
- consider how each component may have been fabricated (the CES software may be helpful for this);
- using the property data provided, consider why each polymer was chosen.

6.3 The piezoelectric ceramic

For the piezoelectric ceramic component:

- use the EDS data to decide which ceramic system is represented by the component;
- use the X-ray diffraction trace and the reference data about sequences of *d*-spacings provided with them to decide which crystallographic phase or phases is/are present;

- do you have sufficient information to identify approximately where this composition would appear on the relevant phase diagram; if not, what additional information would you need?;
- consider how the component may have been fabricated;
- obtain information about the piezoelectric properties of this ceramic.

You may wish to hunt out some more information about relevant properties and prices, e.g. using CES and the web, but you are not expected to demonstrate a detailed knowledge of methods for processing materials and fabricating components.

7. What your report should contain

There is no wish to dictate the precise form that your report should take but there are several points to note. First of all there is a word limit of 2000 words (excluding references and [concise] figure captions). This is a limit, not a target! It is expected that a good report can be written that does not exceed 1500 words. There is emphatically no need to use a word-processor but you may do so, if you wish.

On the first sheet, your report should include your name and College. Your report should include a very brief explanation of how the lighter works, and the emphasis should be on materials identification and fabrication. Hence you should explain the choice of the materials used for the components listed in section 5, and justify their selection. Include sketches where appropriate. You are not expected to demonstrate a detailed knowledge of methods for processing materials and fabricating components.

For the ceramic, you should include an estimate of the stress needed to create a spark across the spark gap in the lighter. You may choose to indicate how Ronson could retrofit the childproof safety device to comply with the new ISO 9994 standard. You may also wish to consider the social economic political and technological changes that have occurred over the last 50 years during which the product was actually made.

Finally, list any references (e.g. textbooks, web pages and useful URLs) that you have used.

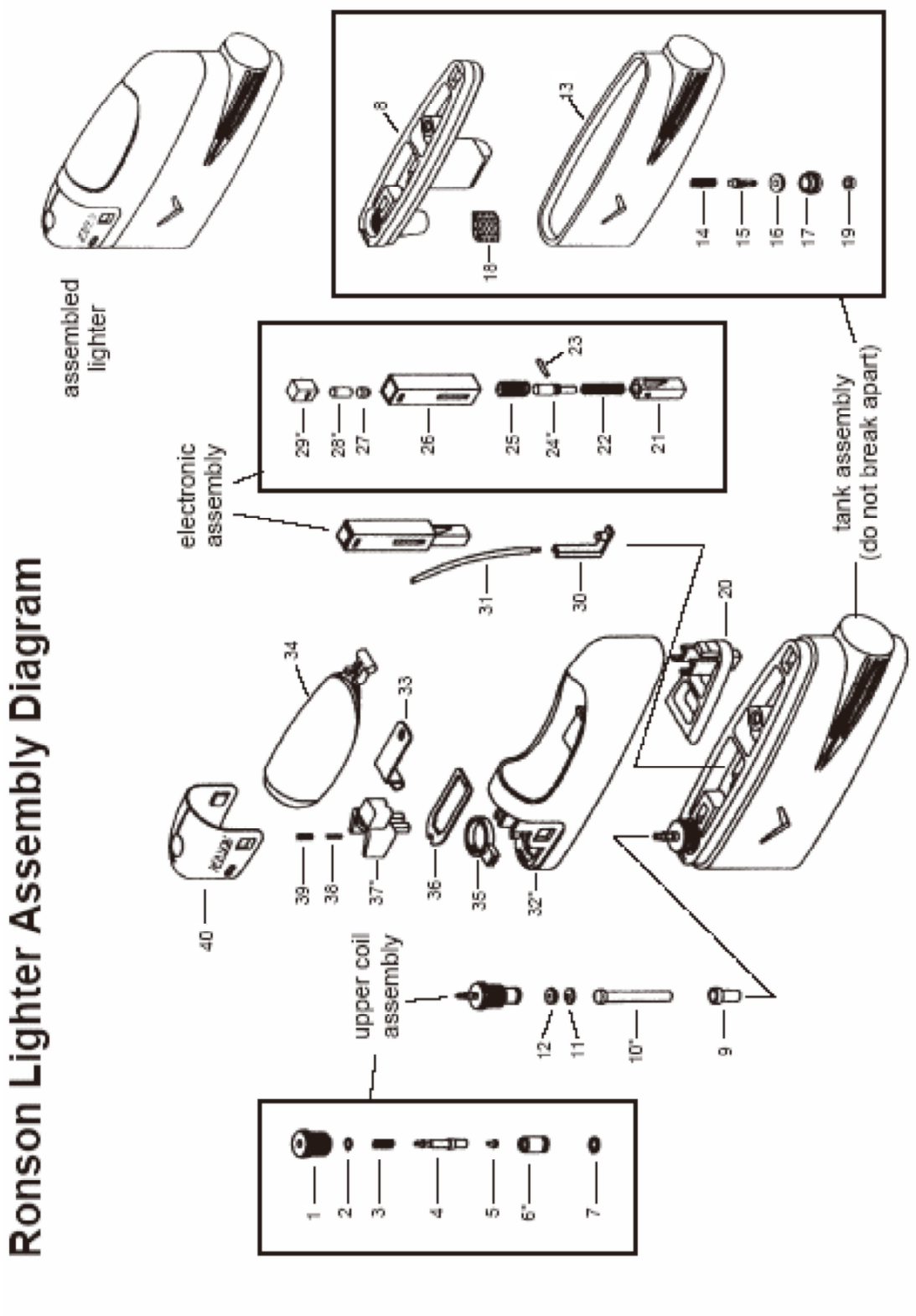
Acknowledgement

We are grateful to Ronson for providing information about this model from their range of lighters.

Ronson Lighter Component List

An asterisk next to the component number signifies that the component is to be studied in detail (see section 5).

Component Number	Component Name	Metal (M), Polymer (P), Other (O)
1	upper coil	P
2	small o-ring	P
3	nozzle spring	M
4	nozzle	M
5	T-packing	P
6*	nozzle bottom	M
7	large o-ring	P
8	cover	P
9	wick holder	M
10*	wick	P
11	T-disk	M
12	filter paper	O
13	tank	P
14	valve spring	M
15	valve	P
16	valve large ring	P
17	bottom cover	P
18	sponge	P
19	valve small ring	P
20	support stand	P
21	inner case	P
22	action spring	M
23	hammer pin	M
24*	hammer	M
25	reset spring	M
26	outer case	P
27	head metal	M
28*	piezo unit	O
29*	backmass	M
30	electronic assembly stand	P
31	pole leader	M/P
32*	bracket	P
33	conductor	M
34	push button	P
35	adjusting ring	P
36	lever	M
37*	pole base	P
38	spring A	M
39	spring B	M
40	cap	M


Ronson Lighter Assembly Diagram
assembled lighter
electronic assembly
tank assembly (do not break apart)
upper coil assembly
1
2
3
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6*
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10*
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Author

We would like to thank Dr. Rob Wallach of the Materials Science and Metallurgy Department of the University of Cambridge for contributing this resource. You can contact him via the website www.msm.cam.ac.uk.

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