Practical 2P1

Materials Selection

What you should learn from this practical?

Science

In this practical you will attempt to link the choice of material, processing routes and forming methods to the demands made by the function and environment of a real engineering component.

Practical Skills

You will learn how to section, polish and etch a wide range of materials. You will then have to deploy your knowledge of materials to research what they are likely to be and why they are used. Whilst you are materials scientists rather than engineers, it is important for you to be aware of the uses to which alloys are put, and the constraints the real world can place on material selection.

Communication Skills

You will learn how to put together and present a scientific poster to communicate your findings. This is a common way research scientists present their findings at conferences.

Overview of practical

Each pair will be provided with a bike pedal. You will need to section this to find 3 different materials (at least one ferrous and one non ferrous), examine them metallographically and in other ways that seem appropriate. You will attempt to determine the material used, and any likely processing routes and forming and joining methods used to make the component. You will then consider why that particular material, etc., was used for the component.

Experimental details

The bike pedal, whilst a simple item that you have all seen, has a tough life. Loads can be high (think of a large man standing on one pedal, and environments will be corrosive). It contains multiple metallic parts (some may not be initially visible!)

Before you make your final choice, think about what each component is meant to do, and what environmental conditions it will be subjected to (stresses, chemicals, wear, etc.), and therefore what **you** might choose to make it from and how. Record this for each of your final choices and ensure your group expects to find a range of materials, with different environmental requirements.

Method of examination

Don't rush into cutting up the component. First of all look at it as a whole; does the surface appear to have been machined, cast or something else? Take photos (they will help with the poster, remember once you have started cutting there is no going back!) Think where there maybe hidden parts.

General colour and appearance? Does it seem to have corroded? Is it magnetic?

Now think before you reach for the hacksaw. Is the surface likely to be treated? Is it likely to vary in any other way from place to place or with direction of section? Choose the cutting direction to examine this. Now cut to a sensible size for polishing. How dense is it? These simple checks can provide a lot of useful information, measuring cylinders and water will be provided.

If necessary, mount the section in Bakelite. Grind and polish to a suitable surface finish.

Hardness testing can be useful to determine how the sample may have been processed. Hardness tables for different alloys are available (online and in the lab). This data can also be related to yield strength.

XRD data for two components will be provided at the end of the practical.

Try some etchants. The SD, JD and lab manager will help with this. The ones that don't work might help with identification, as well as any etch that **does** reveal the microstructure. You may want to etch several times (taking photos along the way) to reveal all the phases present. Examine at low magnifications first to see what large scale variations in microstructure there might be. Then use the optical microscopes to study the microstructure. Take pictures! Choose the magnification(s) used to best show what is going on. Be prepared for the much finer scale microstructural scale of many real alloys (especially steels), compared to the "model" microstructures you have mostly looked at till now.

One sample from each group will be analysed in the scanning electron microscope (SEM) with secondary electrons and EDX (chemical analysis). This sample must be mounted in conductive Bakelite to ensure no charging in the microscope. Point and ID will be used to confirm the composition of different areas of the microstructure – so pick your sample wisely. The more phases present the more interesting it will be. But remember what the resolution of EDX will be as well. Each group will only have about 45mins on the SEM on the second and third afternoons so you need to have your sample ready in time.

Safety note: Make sure you wear a laboratory coat, suitable gloves and eye-protection when etching your samples. Care must be taken when using hacksaws to section samples. Don’t start anything without training or discussing with a member of staff.

Making sense of it

Now go back to the ideas you wrote down **before** you did the examination. Is the material / heat treatment / forming route what you expected? If not, why not? If it is, what alternatives might have been used, and why weren’t they in this case?

Timetable

Day 1

- Choice of components.
- Sectioning and etching.

Days 2 & 3

- Discussion of poster presentation skills.
- Etching and metallography.
- SEM examination.
- Writing-up.

What should be in the report?

There is no write up for this practical. Instead you will produce a poster which you will then present as a group. (This will be presented early in HT 2020)

What should be on the poster?

- **A brief introduction to the bike pedal**
- **What your aims in this practical are**
- **Each component should have a section showing the results**
- **The conclusions you can draw from the results**

Questions you could try to answer for each component (not necessarily all these for all components but try to cover all of them somewhere).

I. What does the component do?

II. What are the principal “loads” on it (stresses, chemicals, temperature, wear, etc.)?

III. What other design constraints are there (shape, possible forming / joining methods, cost...)?

IV. What type of material would you expect?

V. What did your examination of the component tell you about:

   A. What material was used?

   B. What heat treatment it had?

   C. How the surface was treated?

   D. How the component was made?

VI. What alternatives might have been used? Why weren’t they?

VII. How might the component fail?

VIII. How could it be improved?

The poster will be assessed on both the technical content and the quality of the design and presentation. Key here is does it communicate your results effectively?