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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SOME TECHNIQUES MENTIONED IN THE MINI-PROJECT

Scanning Electron Microscopy (SEM)
When a finely-focused beam of electrons is scanned across the surface of a specimen in scanning electron microscopy (SEM) a number of things happen. An incident electron may interact with an electron in an atom in the sample, ejecting that electron from the atom and so creating a vacant state; subsequently another electron will drop into the vacant state with the emission of an X-ray photon with an energy (wavelength) characteristic of the chemical species of the atom (see EDS below). Other incident electrons interact with the sample in a way that causes relatively low energy electrons to be emitted, the number varying with the nature of the sample surface on which the beam is impinging. Known as *secondary electrons,* they can be collected by a suitable detector and the current correlated with the position of the scanning electron beam to form an image of the surface of the sample. This type of microscopy displays considerable *depth of field* so that high magnification images of rough surfaces can be obtained. [This is not a complete list of the possible interactions.]

Energy dispersive spectroscopy (EDS)
By analysing the energy of the X-rays emitted from a sample as the electron beam is scanned in an SEM it is possible to obtain chemical information about the sample. By selecting X-rays of a particular energy it is possible to form an image showing the distribution of the corresponding element across (a thin layer nearer) the surface of the sample. Alternatively the X-ray signals can be integrated over the sample to produce a chemical analysis of the sample. The process used to separate the X-rays of different energies is known as energy dispersion and this form of analysis is called "energy dispersive spectroscopy" (EDS).

Infrared Spectroscopy (IR)
Covalent bonds in molecules behave like springs and can vibrate in a variety of ways, each of which corresponds to a distinct quantum state. Transitions between vibrational states involve changes in the (quantised) energy which often correspond to the energies in the infrared region of the electromagnetic spectrum. A photon having an energy corresponding to the difference between two vibrational states may be strongly absorbed. By measuring the variation in absorption of an infrared beam passing through a sample a "finger-print" related to the vibrational states, and so to the types of bond, present in that material is obtained. By comparing this infrared spectrum with reference spectra it is possible to identify the compounds present in a sample. This technique is called infrared (IR) spectroscopy. In the context of this project, it is particularly useful for identifying organic polymer molecules.
Visiting web page http://chemweb.calpoly.edu/lberberj/IRSpecHandout.doc is strongly recommended.

X-ray diffraction (XRD)
A crystal lattice is a regular three-dimensional distribution (cubic, rhombic, etc.) of atoms in space. These are arranged so that they form a series of parallel planes separated from one another by a distance d, which varies according to the nature of the material. For any crystal, planes exist in a number of different orientations - each with its own specific d-spacing.
X-ray diffraction is a versatile, non-destructive technique that reveals detailed information about the chemical composition and crystallographic structure of natural and manufactured materials.

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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