SYMPOSIUM ON CHEMISTRY & BIOTECHNOLOGY FOR NATIONAL DEVELOPMENT

SHEDA SCIENCE AND TECHNOLOGY COMPLEX

THE PRESIDENCY
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SYMPOSIUM

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THE NEED FOR METAL AND MATERIALS SCIENCE LABORATORY IN NATION'S RESEARCH AND DEVELOPMENT.

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ABSTRACT

Metal and Materials Science have a great role to play in national development. This article discuss some of the equipments that would be necessary in this laboratory. The techniques on specimens preparation of materials are discussed which are the most important routine in the laboratory process.

INTRODUCTION

Metal and Materials Science have been a great role to play in national development. In fact, they are the backbone of any technological development. Understanding the relationship between structure and properties provides the basis for the development of engineering materials that can be easily manufactured in the laboratory. For instance, by manipulating molecular structure, a vast spectrum of polymers have been produced, [1]. Also, controlling microstructure in the laboratory, the development of many new metal alloys and ceramics have emerged. Furthermore, from the laboratories to the production floor, jugging different materials together have resulted in production of composites that have unique properties for use in engineering. In engineering material, scientific understanding is used to shape materials into useful products. Materials processing both depends on influence of the structure and the properties. The understanding of these processes can only be achieved in the laboratories. For example, we can obtain directional properties while casting or deforming metals. The directional properties thus obtained can in turn influence the subsequent processing and behaviour of the metal. Therefore, science and processing must link together in order to understand and select materials for engineering applications. In this era of structural Adjustment Programmes (SAP), many industries have been forced to source for local raw materials in substitute for imported metals and materials.

To succeed in achieving this, metal and materials science laboratory would play a great role. No one doubts that testing, measuring and quality assurance are vital components in any new products. The analysis of different catastrophic failures in engineering which could result to death in some cases can be performed in the metal and materials science laboratory. Such as intercrystalline, intergranular and quasi-cleavage embrittlement as well as ductile dimples. By performing such analysis, death occurences in industry when such catastrophic failures happened can be prevented and help various engineering manufacturers to select the necessary engineering materials.

The aim of this paper therefore is to highlight the modern laboratories equipments need in nation's research and development.

MODERN EQUIPMENTS NECESSARY IN THE NATION LABORATORY OF RESEARCH AND DEVELOPMENT FOR METAL AND MATERIALS SCIENCE.

Some of the modern equipments that are necessary in nation research and development for metal and materials science, are as followings: The universial testing machine is used to ascertain the machanical properties of wide range of materials including, plastics, rubber, metal fabrics, yarns, composites, foils and so on. Such testing machines provide the facility for testing in tension, compression, flexure and shear. The impact testing equipment, is used to test the amount of energy absorbed when there is collision of materials. The hardness testing machines are for microhardness and hardwearing. The stress corrosion and corrosion fatique testing equipment could be used for studying the corrosion problems in our oil and food industries.

The scanning acoustic microscopy, is a relatively new technique which offers material scientists the ability to image surface or sub-surface structures acccording to variations in their elastic properties. It can be used in the study of ceramics, polymer, image surface or subsurface features nondestructively and with minimal specimen preparation. Scannining electron microscopy (SEM) and all its variant modes, has become increasingly used for studying, many new materials such as semiconductor devices, in which such properties as morphorlogy, composition, carrier density, temperature and luminecence efficiency have all been assessed.

Transmission electron microscopy (TEM) is one of many modern techniques used to investigate and assess the properties of many new engineering materials. Electron diffraction, is the best techniques for providing information about local structure on a range of scales extending from atomic dimensions to a few microns.

Fluorescent light microscopy of inorganic materials. This equipment is used to examine ceramics, composites, sprayed coating or concrete for porosity. This equipment comes into being due to difficulties in establishing whether the black holes observed microscopically are true porosity or have been caused by the abrassive microsectioning process. To assist in the identification of the true structure, vacuum impregnation with an expoxy-containing fluorescent dye can be used. Fluorescent light microscopy is a method of producing a contrast between areas impregnated with the resin-loaded dye and the main material structure. This is achieved by selecting filter combinations which reflect and transmit specific wavelength of light. The 3460 metals analyser, is the workhorse for routine production control, which can be used to analyse composition of metals in foundries, forges, minimills and casting operations. The nation laboratory, may acquire such equipment to facilitates the developments of new alloys metals for the engineering purpose.

The nation laboratory needs to take a look at the frequent power failure at National Electric Power Authority (NEPA) as a result of the malfunction of the engineering components. Since these engineering components are operating at high temperature, there are need to have modern equipments to be used for testing high temperature materials. The uniaxial creep testing equipment which has the ability to interpret and predict behaviour of materials is an ideal for the nation laboratory.

For the purpose of this paper techniques on specimens preparation for metallography and electron microscopy examination will be discussed. This is because specimens preparation for examination is the most important routine in the metal and materials science laboratory.

METALLOGRAPHY SPECIMEN PREPARATION

Before a metal or material can be viewed under the optical microscopy, to ascertain the structure and properties which would provide the basis for development of new materials understanding the specimen preparation is required. The Bousfied [2] concept, which described the method of specimens preperations for metallography examination could be adopted. This method showed that the traditional way to achieve sample integrity is to use successively finer abrasives.

Thus depends on the depth of the deformed layer before any abrasive are used and the limit at which each abrasive will no longer bring the surface closer to integrity. It is also better to make allowance for the residual stress. Residual stress reveals itself more abviously in softer materials, sometimes resulting in twinning. To allow for residual stress 25 % should be added to the dimension of the deformed layer in the case of hard materials, and 50 % for soft materials. After achieving the optimum condition of the abraded surface which have been ground on silicon carbide papers. The next stage is polishing to 1 um diamond finish which must be done carefully to get to correct surface for viewing.

ELECTRON MICROSCOPY SPECIMEN PREPARATION

The high resolution attainable with transmission electro microscope (TEM), which provide direct magnification up to many thousand times, make this an understanding technique for examining the microstructure of materials unique. However, the thickness of the specimens must be restricted to 100-200 nm (depending on material and electron beam energy) to avoid undue absorption of the incident electrons. It has therefore be necessary to develop methods for preparing , thinning specimens of materials with widely differing mechanical and chemical properties.

For some metals, semiconductors and other inorganic materials, chemical etching and electrolytic techniques are suitable to thin the material to perforation. The areas found the perforation are usually sufficiently transparent to electrons to allow micrographs to be taken. Difficulties arise when materials are not homogeneous; preferential etching may occur, second phases may be leached out and in semiconductors, p-type material may etch at a different rate from n-type material. Even when a material can be controllably etched, the etchment may form a contaminating layer on the surface.

Castaing and Labories [3] developed a new preparation method to avoid the difficulties encountered when attempting to thin aluminium alloys containing 4 % copper by electrolytic polishing. With the electrolytic technique, an oxide layer formed and some redeposition of copper occured. The Al_2Cu precipitations etched more slowly than maxtrix and give rise to relief structure. As soon as hole appeared, the edges dissolved rapidly, leaving few thin areas. Instead of electrolytic polishing, they used a two stage process involving mechanical followed by etching of both faces in succession with a parallel beam of 2000 eV ion. The resulting specimen was clear, without oxide films, an enhanced rate, and the rate of erosion (about 0.05 un min^{-1}) was controllable.

Although this method and others have helped to get thinning specimens for electron transmission microscopy (TEM), as more new materials are being produced, more new methods of thinning specimens preparation are emerging, such as ion beam technology. Such preparation will help the nation to prepare the semiconductor materials that may have been developed locally for the electron microscopy examination.

CONCLUSION

This paper has covered a few equipments that can be used in metal and materials science Laboratory in nation's research and development. The techniques on specimens preparation of materials for examination through metallography and electron microscopy are discussed. With this piece of information in the report, the need for metal and Materials Science Laboratories can be justified.

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