Transmission Electron Microscopy

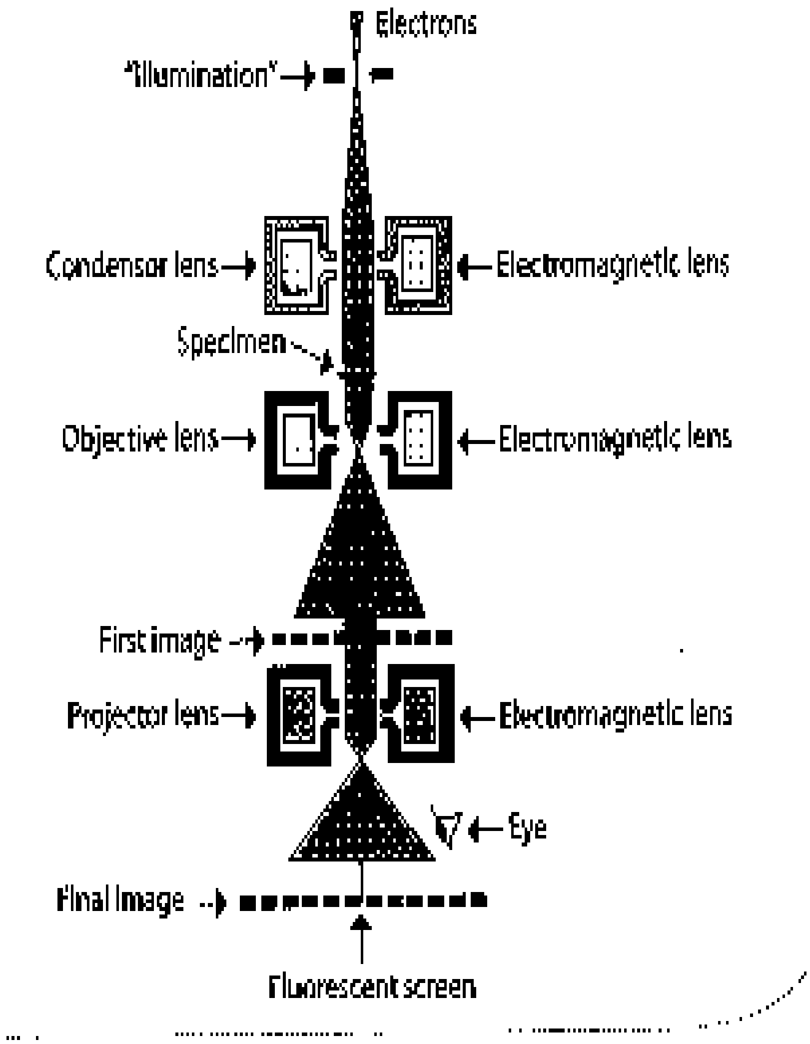
Introduction

Microscopy is a means by which an object is transformed in to magnified image. There are different ways for magnifying the images of very small objects by large amounts. In any type of microscopy (optical microscopy or electron microscopy), a wave of wavelength λ (light wave or electron wave) interacts with the matter and as a result of this interaction we get the microstructural information about the object. As the study of the materials at the nano-metric level is drawing much attention of the researchers in the current era, Electron Microscopy becomes a very important physical characterization tool at the nano-metric level. Electron Microscopy stands far ahead of the optical microscopy as it can provide the much improved resolution and depth of focus compared to optical microscopy.

This is a very introductory report on the basics of the electron microscopy (particularly on Transmission electron microscopy). Transmission electron Microscopy (TEM) operates on the same basic principles as the light microscope but uses electrons as "light source" and their much lower wavelength makes it possible to get a resolution thousand times better than with a light Microscopy.

Working Principles

TEM images are formed using transmitted electrons (instead of the visible light) which can produce magnification details up to 1,000,000 x with resolution better than 10 A^o. The images can be resolved over a fluorescent screen or a photographic film. Furthermore the analysis of the X-ray produced by the interaction between the accelerated electrons with the sample allows determining the elemental composition of the sample with high spatial resolution.



Electrons
"Illumination"
Condensor lens
Electromagnetic lens
Specimen
Objective lens
Electromagnetic lens
First image
Projector lens
Electromagnetic lens
Eye
Final image
Fluorescent screen

Working principle of TEM

TEM in SAIF IITB

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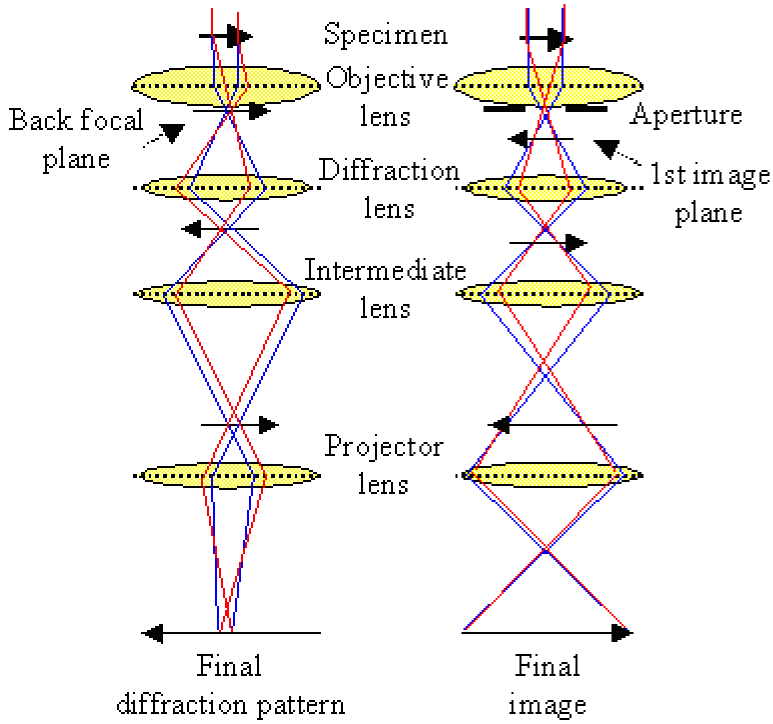
Sunday, June 27, 2010

TEM OPERATION

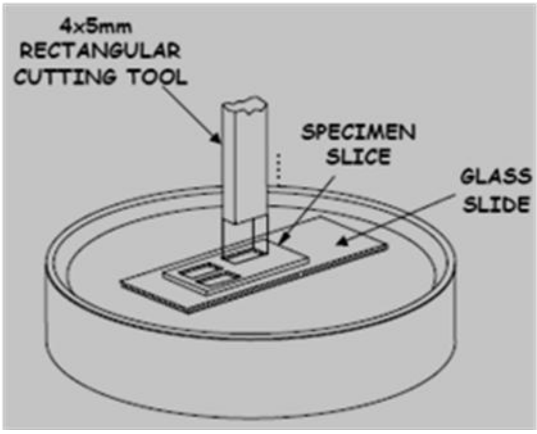
TEM offers two method of specimen observation (a) to form diffraction patterns by using selected area apertures and focusing the intermediate lens on the diffraction pattern formed in the back focal plane of the objective lens. (b) to form images by bright field , dark field , or lattice image phase contrast modes-



SAMPLE PREPARATION

Sample preparatipn in TEM can be a complex procedure. TEM specimens are required to be at most hundreds of nanometers thick, as unlike neutron or X-Ray radiation the electron beam interacts readily with the sample, an effect that increases roughly with atomic number. High quality samples will have a thickness that is comparable to the mean free path of the electrons that travel through the samples, which may be only a few tens of nanometers. Preparation of TEM specimens is specific to the material under analysis and the desired information to obtain from the specimen. The steps, involved in the thin-film or quantum dots (grown on wafer by using MBE or MOCVD) sample preparation for cross-sectional imaging, are discussed below.

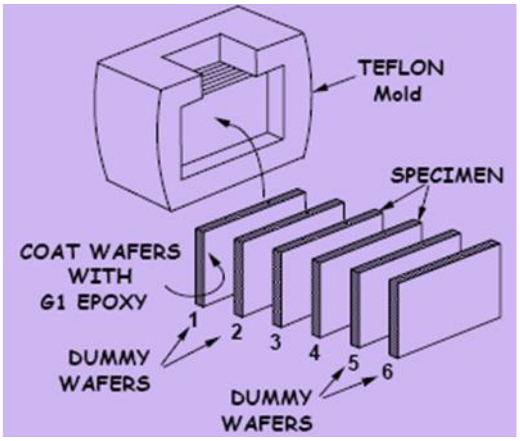
1- Cut the small rectangular pieces from the big sample with the help of ultrasonic disc cutter(4*5mm).The samples on which you want to do XTEM should be coated with some deposition eg.Cr,Au(30nm,70nm). Deposited material should be around 100nm.



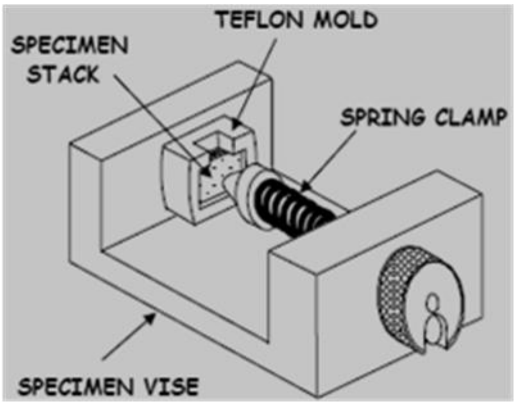
Ultrasonic Disc Cutter Tool:

NOTE: While loading the Cutter (Rectangular and cylindrical) rotate with your hands and then with the tool mentioned in the picture rotate just about 90 degree. Please don't tight the cutters forcefully.

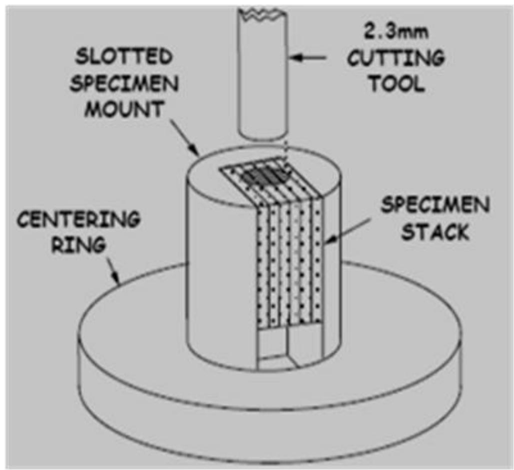
- Glue these pieces together with the help of epoxy glue(hardner and resin 1:4 ratio) (Length of stack should be of 4 mm, specimen should be kept in middle).



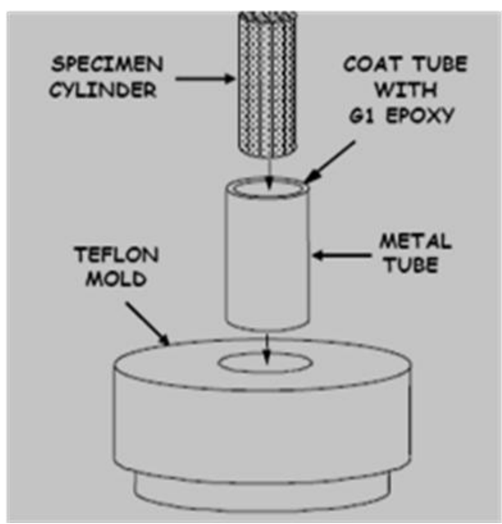
- Cure glued stack under pressure to form a strong bond between wafers with the help of a spring system



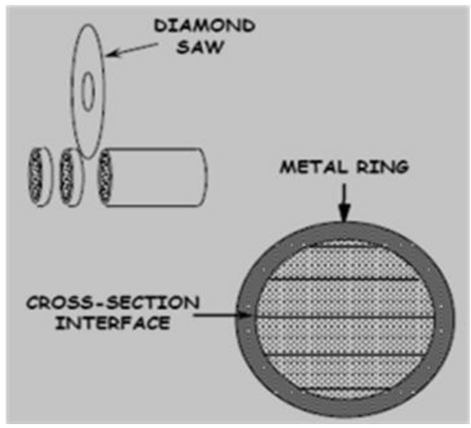
- Cut the cylinder from the stack with the same ultrasonic disc cutter (2.3mm diameter, keep specimen in the centre).



- Insert this cylinder in to a metal tube and Cure this metal tube on the hot plate



- Slice out the metal tube in to the rings (about 400µm thickness) with the help of a diamond saw and accessories



Diamond saw Tool:

- Thinning of the rings is done with the disc grinder till the thickness reaches to 80μm.

- A dimple is then created in thin ring with the help of dimple grinder of about 40 μm depth.

Dimple Grinder Tool:

- The sample is further thinned to electron transmission using an ion milling system (Specimen perforates just in the neighborhood of interfaces, the area surrounding the perforation is of our interest).

<u>Precision Ion Polishing System:</u>

- Now the sample is ready for keeping it inside the electron beam in TEM set up.

Conclusions

TEM is an established technique for examining the crystal structure and the microstructure of materials. It is used to study all varieties of solid materials: metals, ceramics, semiconductor, polymers, and composites. With the common availability of high-voltage TEM instruments today, a growing emphasis is being placed on atomic resolution imaging. Future trends include the use of ultrahigh vacuum TEM instruments for surface studies image analysis and computerized data acquisition for quantitative image analysis.