Transmission Electron Microscopy

Instrumentation

Introduction

- Transmission electron microscope is a microcopy technique in which a beam of electrons is transmitted through an ultra thin specimen, interacting with the specimen as it passes through.
- An image is formed from the interaction of the electrons transmitted through the specimen, the image is magnified and focused onto an imaging device, such as a fluorescent screen, on a layer of photographic film, or to be detected by a sensor.

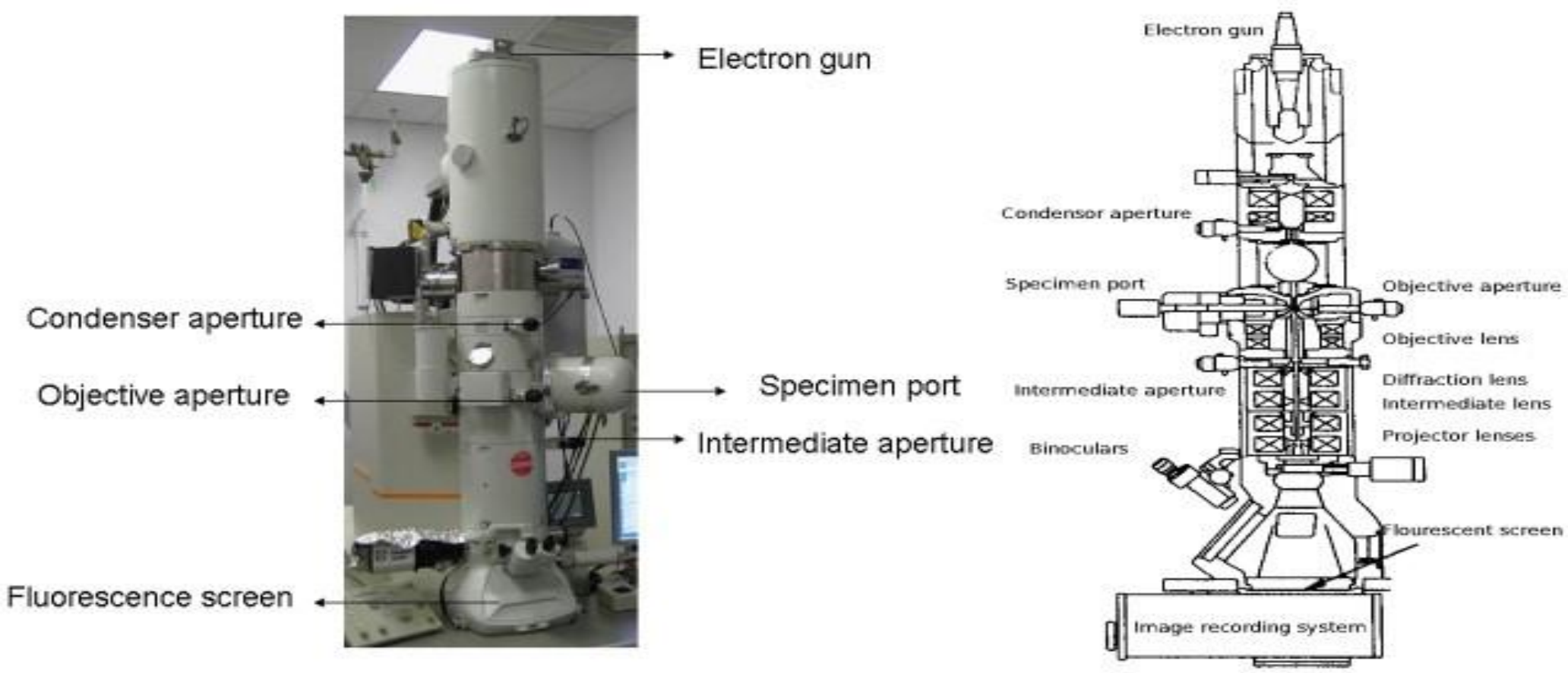
Components

- Electron Source: produces high energy, large current, high coherence electron beam necessary for generating diffraction patterns and high spatial resolution images
- Condenser lenses: control spot sizes and illumination area on sample.
- Objective lens: images sample and is strongest lens in the system.
- Intermediate and projector lenses: changes modes from diffraction to imaging.
- Detectors: various different configurations designed to collect secondary signals produced by the high-energy electron beam.

Principle

- TEM is complex and sophisticated but the basic principle behind its operation can be readily understood.
- A heated tungsten filament in the electron gun generates a beam of electrons that is then focused on the specimen by the condenser.
- Since electrons cannot pass through a glass lens ,magnetic lenses are used to focus the beam.
- The column containing the lenses and specimen must be under high vaccum to obtain a clear image because electrons are deflicted by collisions with air molecules.
- The specimen scatters electron passing through it, and the beam is focused by magnetic lenses to form an enlarged , visible image of the specimen on a fluorescent screen.
- A denser region in the specimen scatters more electron and therefore appears darker in the image.
- In contrast, electron-transparent regions are brighter.
- The screen can also be moved aside and the image captured on photographic film as a permanent record.

Instrumentation



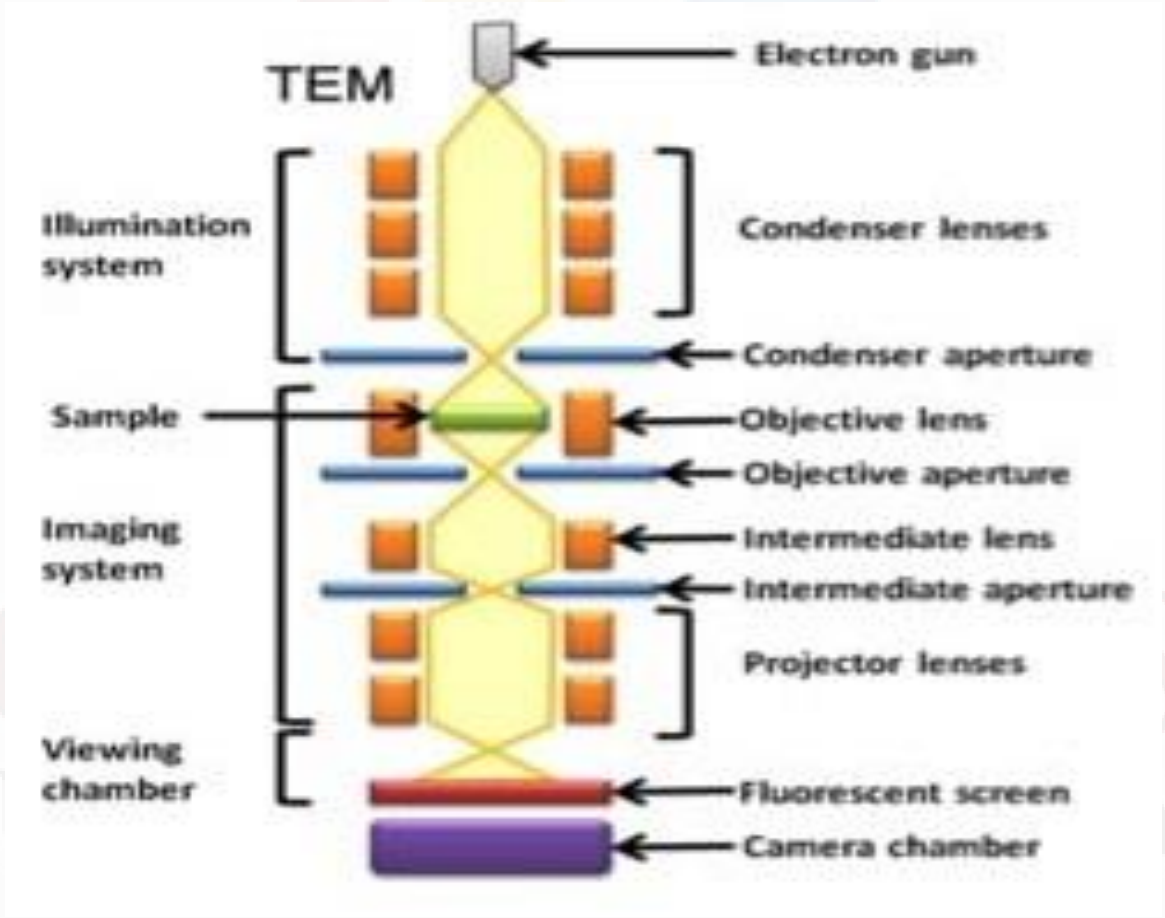
Advantages

- TEMs offer very powerful magnification and resolution.
- TEMs have a wide range of applications and can be utilized in a variety of different scientific , educational and industrial fields.
- TEMs provide information on element and compound structure.
- Images are high qualified and detailed.

Disadvantages

- TEMs are large and very expensive.
- Laborious sample preparation.
- Operation and analysis require special training.
- Samples are limited to those that are electron transparent.
- Images are black and white.

Ray diagram


TEM
Electron gun
Illumination system
Condenser lenses
Condenser aperture
Sample
Objective lens
Objective aperture
Imaging system
Intermediate lens
Intermediate aperture
Projector lenses
Viewing chamber
Fluorescent screen
Camera chamber

References

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