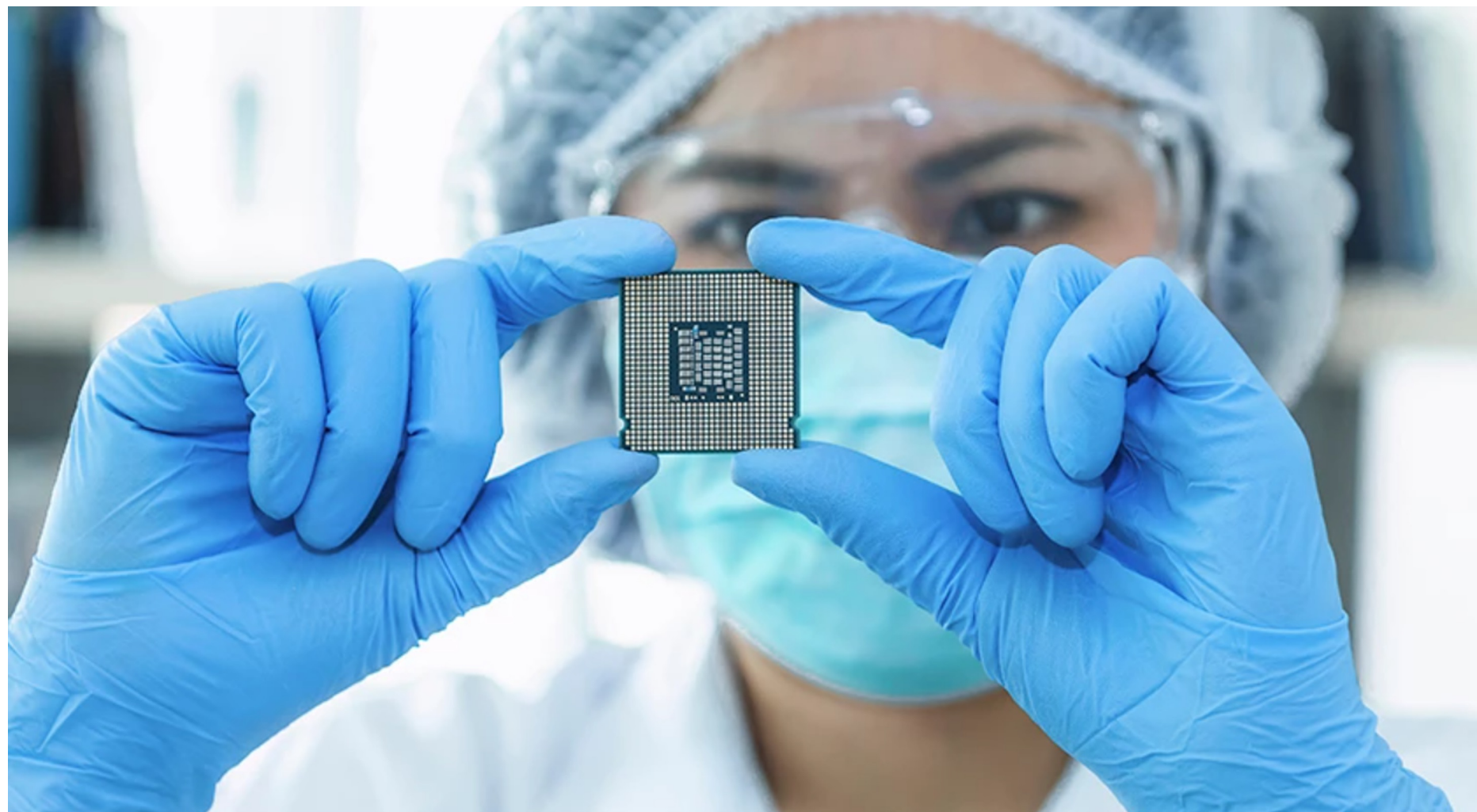


Semiconductor FA - Materials Analysis Training

Robert D. Cormia
Foothill College



Overview

- Role of materials characterization and failure analysis
- Typical sample analyses, tools and methods
- KSA requirements, typical staffing
- Technician and analyst training, theory and practice
- Internships and experiential learning

Role of materials characterization and failure analysis

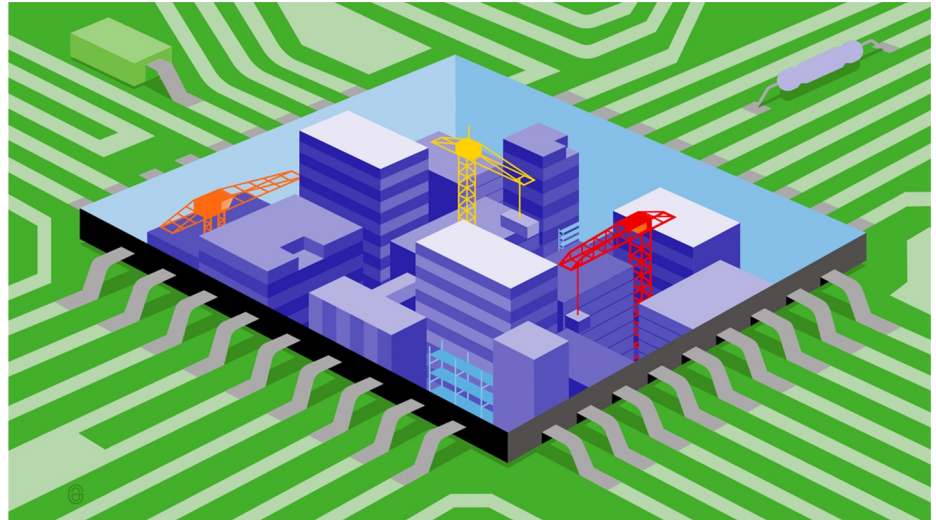
Materials characterization for R&D

Process development and optimization

Inspection and QA/QC

Defect and failure analysis

Authenticity testing



Typical analyses

Wafer inspection

Oxide and thin film thickness

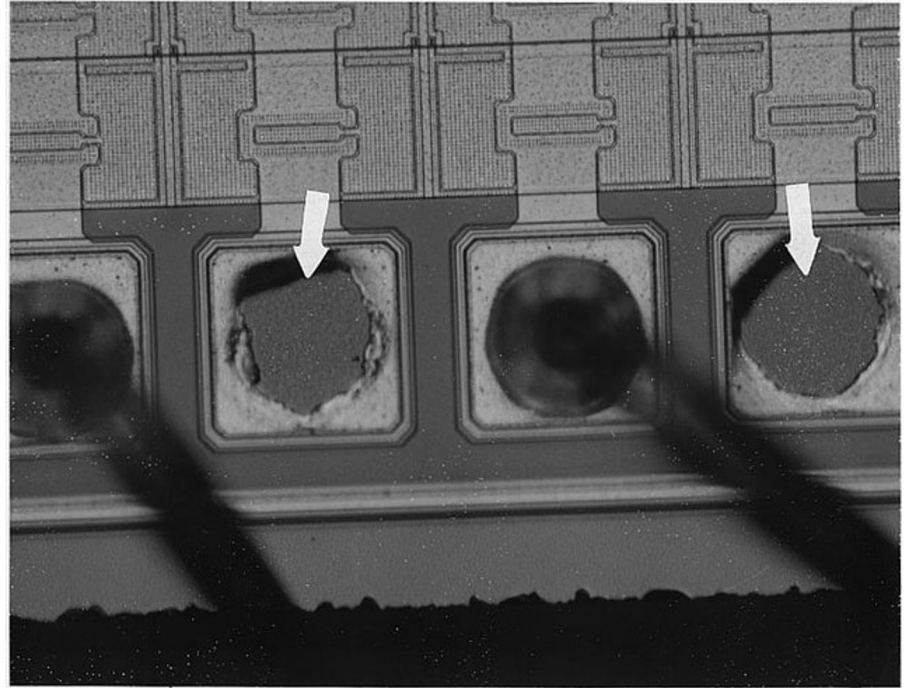
Bond pad analysis

Contamination

Circuit tracing and repair

Package failure

Authenticity



Failure Analysis of Bond Pad Metal Using FIB and AFM

Typical staffing and KSA requirements

Scientist - PhD and Master's degree

Analysts - Bachelor's and Master's degree

Technician - AS and Bachelor's degree

Knowledge of materials, instruments, processes, and methods

Skilled in the operation of SEM, TEM, FIB, AES, XPS, thermal / x-ray imaging

Ability to apply tools in the context of R&D or failure analysis

The role of a technician in an FA laboratory

Routine testing, standard QA/QC and inspection methods

Electron microscopy imaging for QA/QC failure analysis

Collection and interpretation of standard data (spectra)

Sample preparation, especially for SEM, TEM, and FIB

Electrical testing of failed or suspect devices for preliminary diagnostics



Instruments operated

Electron microscopy (SEM, AFM, TEM, FIB)

Surface analysis (AES, XPS, SIMS)

Thermal and x-ray imaging (IPC inspection)

Non-destructive testing (NDT)

Electrical testing



Vintage SSX-100 XPS Spectrometer - University of Toronto



Eurofins - MASER Engineering

FAILURE ANALYSIS TECHNICIAN SKILLS



- 1 Failure Analysis
- 2 Test Equipment
- 3 Troubleshoot
- 4 Component Level
- 5 Sample Preparation
- 6 Assembly Line
- 7 Reliability
- 8 Test Scripts
- 9 Laser
- 10 ION Beam

Typical training programs

Short courses in materials analysis

College level materials characterization and FA

Hands on training on SEM, TEM, FIB

Internships in cleanroom manufacturing (QA/QC)

Externships in commercial analytical labs



Concept (theory) vs. hands-on instrument training

Physics and chemistry

Background of instruments

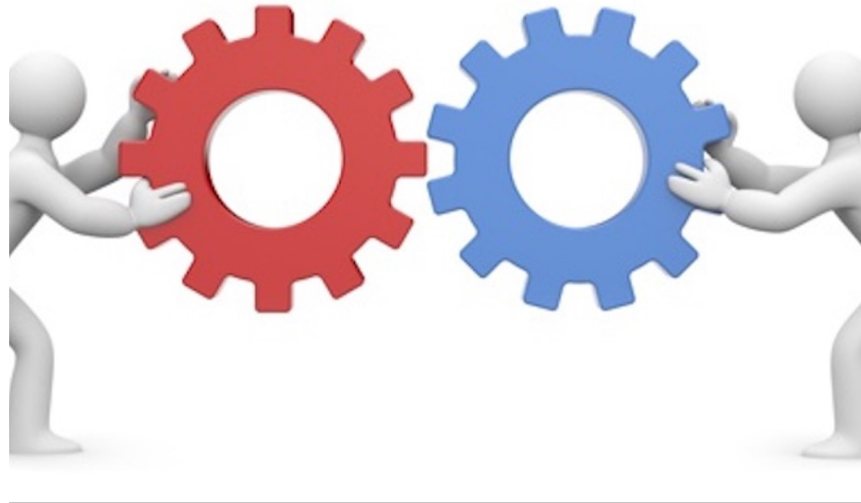
Materials science fundamentals

Hands on instrument operation

QA/QC repetitive testing

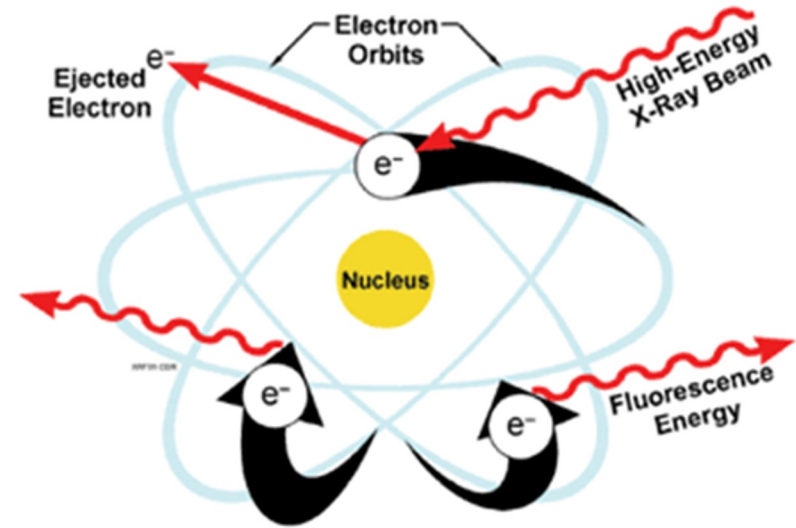
Failure analysis (FA)

5-step rubric



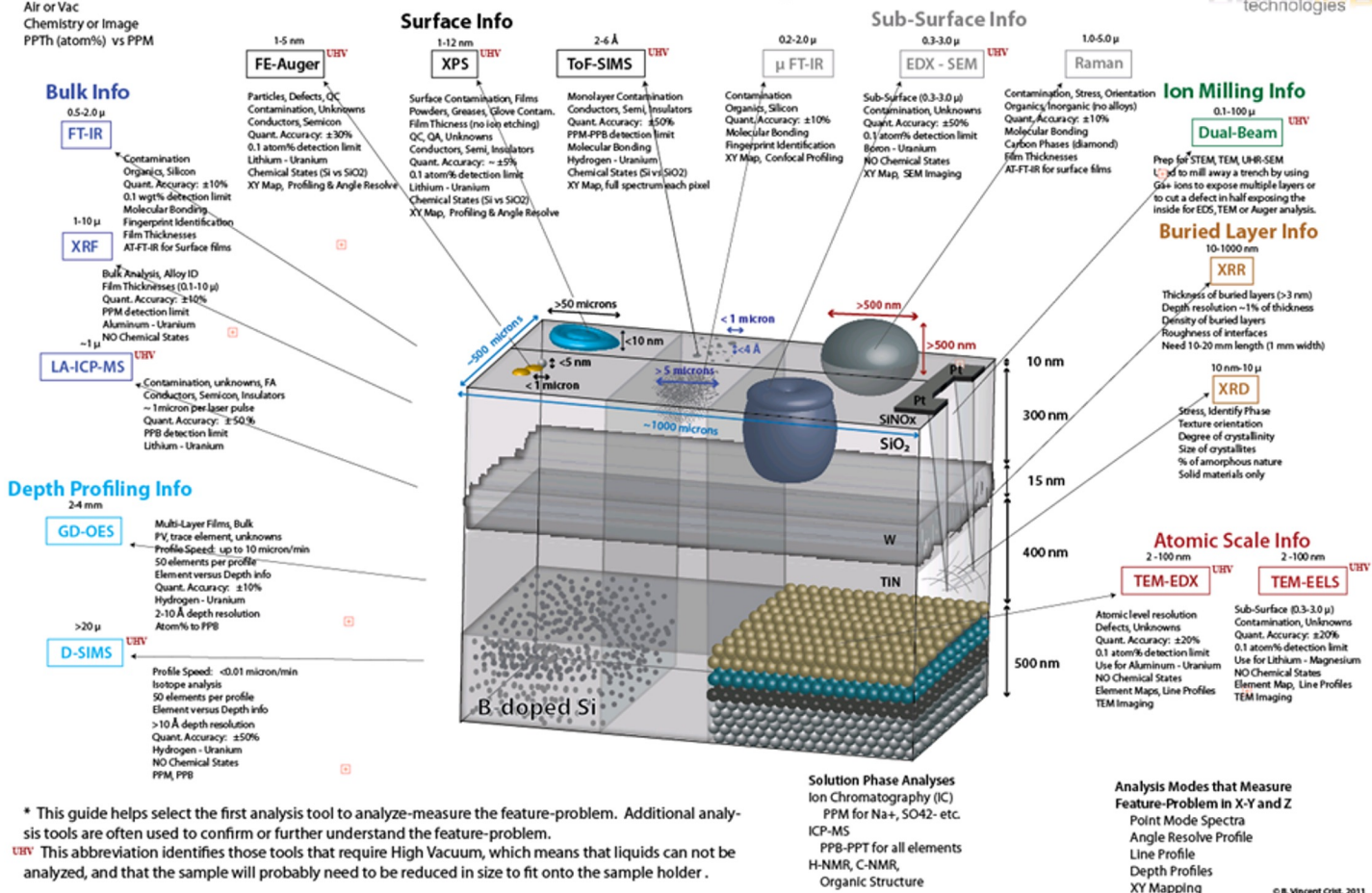
5-Step Rubric: Learning (how) to use an instrument

1. What is the physics?
2. What is the information?
3. What types of samples can you analyse?
4. Who uses this instrument?
5. To solve what types of problems?



Legend for Tool
 Applications
 Example Data
 Photo of Instrument
 Air or Vac
 Chemistry or Image
 PPTH (atom%) vs PPTH

Feature-Problem-Analysis-Tools Guide to Selecting Tools*



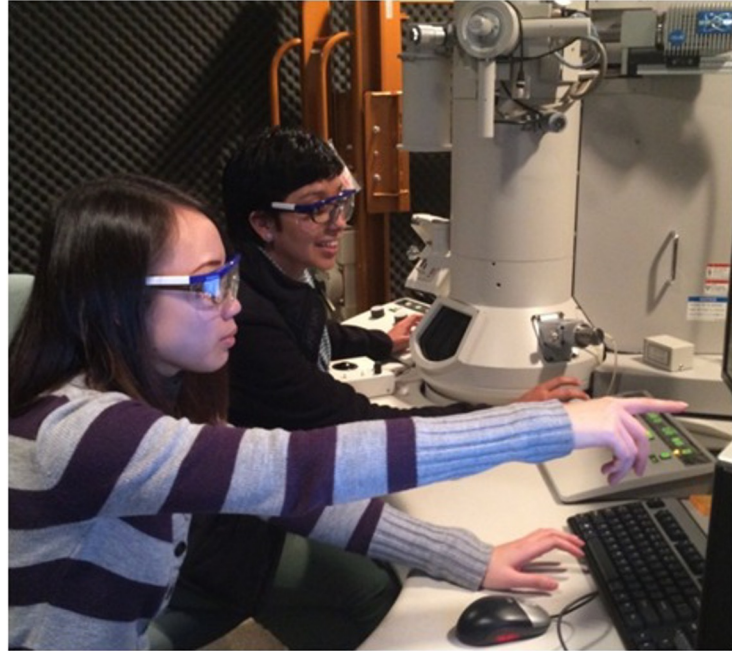
* This guide helps select the first analysis tool to analyze-measure the feature-problem. Additional analysis tools are often used to confirm or further understand the feature-problem.

UHV This abbreviation identifies those tools that require High Vacuum, which means that liquids can not be analyzed, and that the sample will probably need to be reduced in size to fit into the sample holder.



Foothill College students training on NASA-TEM

Foothill College students Anh Nguyen and Yessica Torres training at NASA-ARC on a Hitachi HRTEM. Funding for the training was provided by the National Science Foundation (NSF) nanotechnology technician training program (NSF-ATE 0903316) Students first trained on the Hitachi TM-3000 tabletop SEM at Foothill College. Two of the students went on to operate a TEM (UC Davis) and FIB (EAG Labs). Students learned to operate the Hitachi 9500 HRTEM with about 10 hours of hands-on training.



Typical wages for materials analysis / technicians

Scientist (**\$150K**)

Operate SEM, TEM, FIB, AES and XPS

Analysts (**\$100 - \$125K**)

Operate SEM, TEM, FIB, or AES and XPS

Technicians (**\$90 - \$120K**)

Operate SEM, FIB, thermal imaging



Summary

The need for materials characterization and failure analysis

Supporting semiconductor R&D, process development, and failure analysis

The role of a technician in a cleanroom or commercial analytical laboratory

How to best train for KSA, complicated instruments, and real-world problems?

Blending concept (theory) with hands-on instrument training

Opportunities for advancement and growth as a materials analyst / technician

References

EAG Failure Analysis (Eurofins)

Jeol - NeoScope 7300

Metallurgical Engineering Services

Ansys Electronic Failure Analysis

Zippia - Failure Analysis Technicians

SPIE - Integrating Electron Microscopy into
Nanoscience and Materials Engineering Program