Buildings for Advanced Technology Workshop II

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The RIGHT levels of "Clean" for Advanced Technology Environments Part 1 – Asking the Right Questions

Presented by:
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Buildings for Advanced Technology Workshop II
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Overview:

Nanoscience research facilities do not require the same level of "clean" that microelectronics production plants do. Creating "clean" space is costly, so you want to make sure you don't specify higher levels of "clean" than are necessary, or more clean space than you need. Here Abbie Gregg and Craig Rossrucker set out a strategic planning process for deciding levels of cleanliness. This presentation addresses the questions that users need to ask and implications of the answers.

Future presentations will illustrate how to achieve those levels at the lowest possible cost. Using current project information, they examine the spectrum of options ranging from cost-effective cleanroom designs to micro-environments, and set out guidelines for making "clean-cost-flexibility" decisions.

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Key Concepts

- Ask the right questions } **Today's Presentation**
- Know the expensive answers
- Match the environments: ambient, liquid, gas
- Provide upgrade flexibility

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? ? ? ?

Ask the Right Questions

- What Now?
- What in 5 years?
- What in 10 Years?

- **Technology and Research Descriptions:**
  - Device Type (s): Nanoelectronics, MEMS, Biochips.
  - Nano Molecules – self assembling, self aligning
  - Genomics – Recombinant DNA, Gene therapy
  - Future Process types
  - Future Experimental "devices"
  - Mars Sample Retrieval Facility – 2016 and Beyond

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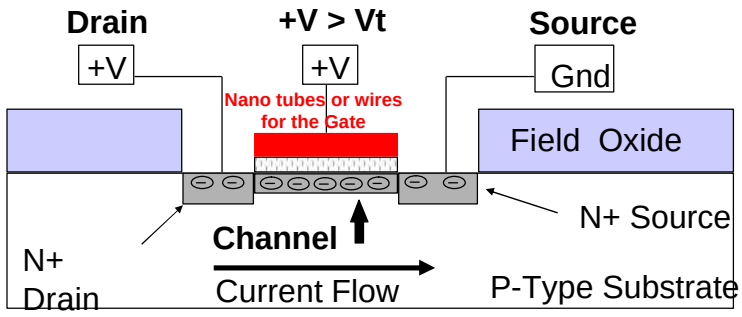
Nanotechnology Applications Transistors



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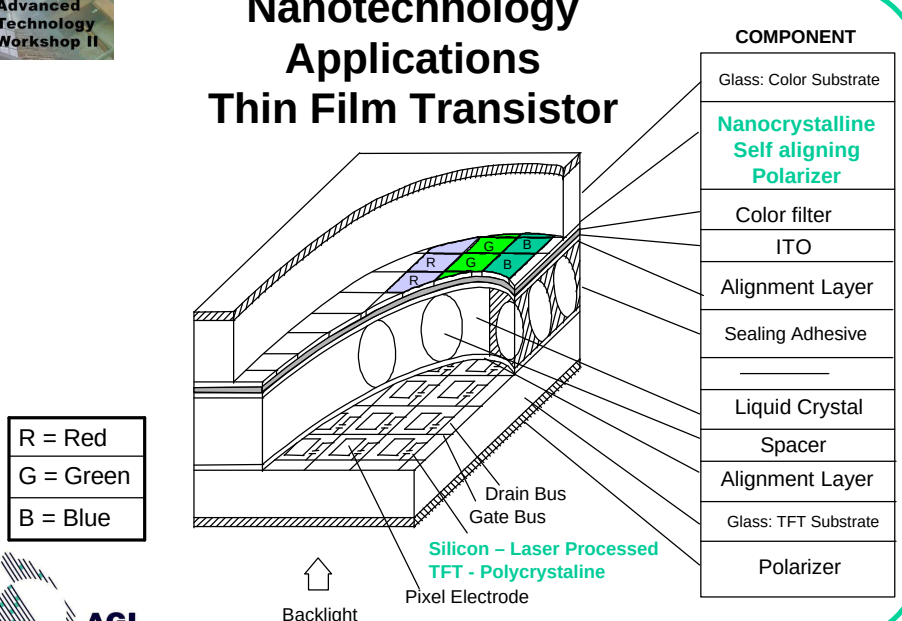
Nanotechnology Applications Thin Film Transistor



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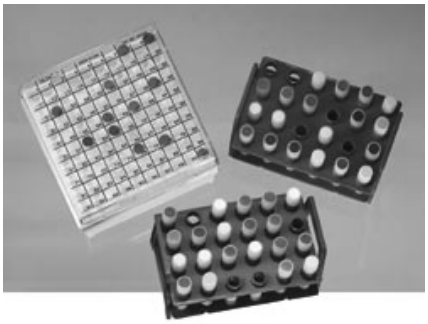
Nanotechnology Applications Biotech

Chip Array Assemblies
DNA and Protein Handling
for Genomics Analysis



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Ask the Right Questions

- Substrate Type (s) ?
  - Silicon (N, P), III-V, Quartz
  - Flexible stainless, PEN…
- Process Technology ?
  - What Materials will "poison" the experiments?
  - What Materials are essential?
  - *Remember: The job of your new cleanroom facility is to keep everything **OUT** except what you want to allow **IN***
- Minimum Feature Size?
  - Nanotech ≅ 20nm ± (0.02 microns)
- Number of Mask Levels/Process Steps?
- Key Processes?
- Typical Lot Traveler or Process outline?

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Nanotechnology: Defect Issues

- Can we trust our experimental results with high defect density?
- Fine line lithography/dense complex patterns (more chance for catastrophic damage per square area of surface)
- Long Cycle Time or re-entrant flows give defects the chance to accumulate.
- How much time are your products exposed to potentially contaminated environments?
- Will a defect nucleate a large "error" in a nanocystalline array or a genomic analysis?


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WHAT SIZE DEFECT IS A KILLER?

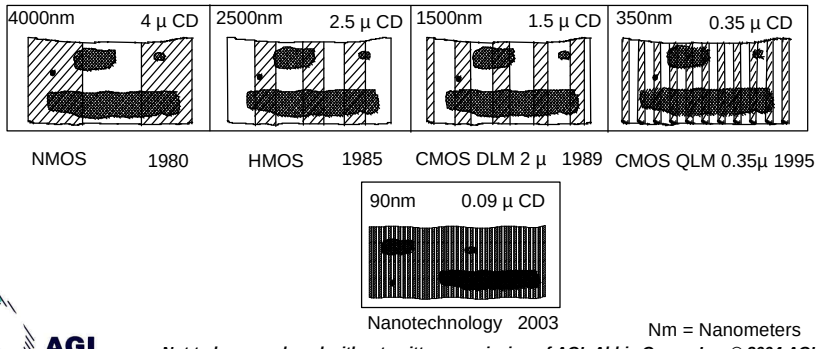
~ 50 nm — Amines

0.2 - 0.4 µ ? 200 – 400nm — Cigarette Smoke

2 µ ? 2000nm — Bacteria

8 µ ? 8000nm — Skin Flake

IT DEPENDS ON FEATURE SIZE:



Nm = Nanometers

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Process Descriptions

Processes commonly used in Semiconductor, FPD, MEMS, Biotech and Nanotech Fabrication:

Patterning Cleaning Etching

Doping Depositing Thin Films Heat Treatment

Inspection/Measurement Planarization Coating

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Ask the Right Questions

- Things to look for:
  - Sticky Surfaces on substrates (flypaper effect)
  - High temperature processes (incorporate and diffuse damage)
  - Wet Process (DI Water is more important than clean class, single pass air required for fume exhaust)
  - Bio – Hazards (HEPA Filtered exhaust and % of Recirc vs. single pass air)
  - Vacuum Processes (protection from ambient environment)

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Ask the Right Questions

- Can some areas be less clean?
  - ➢ Test
    - Is substrate protected from damage during test?
    - Will substrate re-enter the clean process flow?
  - ➢ Assembly Technology
    - What is minimum discrete element size (eg wire?)
    - How clean are the tools?
  - ➢ What experimental Yield is needed to Prove Concept?
    - Is pilot line expected to produce predictable yield results?

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And Now the First Really Hard Question:

- Substrate Size (s) –
  - ➢ Minimum (1/4 inch chips) to Maximum (200mm, 300mm)
  - ➢ 4”, 6” round are common form factors
  - ➢ The size and configuration of the cleanroom area and how you will be able to keep substrates clean within the equipment depends on this answer.
  - ➢ This answer determines
    - ▪ tool size
    - ▪ load configuration
    - ▪ chamber configuration
    - ▪ material handling options
  - ➢ Are People handling the materials? OR Minienvironments and robots

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MIX OF ADAPTIVE/INTEGRAL SMIF AND CEILING HUNG/TOOL MOUNTED MINIENVIRONMENT

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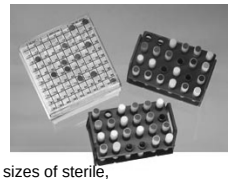
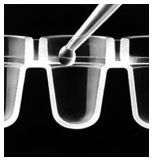
Examples: Sterile Containers for Sample Storage, Movement and Testing



Many shapes and sizes of sterile, autoclave-able containers

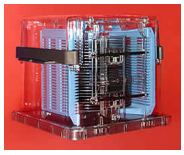


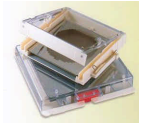
Molecular level in size

Storage on a glass slide. Plastic frames for robot handling

Sterile Microcapsules can hold a single grain of dust

Microcapsules in Sample Library





Semiconductor Carriers used to keep materials clean

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Equipment List

- Existing Equipment and Future Equipment (blue sky- 2-10 years)
- Useful Information for Each Piece of Equipment
  - Required Utilities: Volume, Pressure.
  - Chemical and gas purity, contamination risks.
  - Exhaust (one pass air)
  - Electrical requirements and Heat Load to the room
  - Dimensions – especially HEIGHT
- Process Sequence:
- Tool Configuration Options
- Quantity and Phasing of equipment.
- Support tools: reticle inspection, parts clean.

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Facility Conditions Questions

- Building
  - Site plan, available square footage ?
  - Available Square Footage for each intended use ?
  - Area available for support, air handling and utilities ?
  - **Available height for cleanroom envelope ?**
- "House" Utilities: Clean Dry Air, Nitrogen, DI water
  - **Quality** of these also determines process environment
    - Particle count/size
    - Contaminates
    - Dew point of Air
- Temperature and Humidity Requirements: Nominal and ranges, and the specific process to which they relate.
- Cleanliness Requirements:
  - ***Clean Class for each process.***
  - Mini-environments or general room conditions, by area.
  - Raised Floor vs. Side Wall Return – by area
  - Interior design and layout issues affecting Clean Class (bulkheading, etc.)

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People Issues

- Number of people working in each area
- Gowning
- Viewing
- Communication
- Supervision
- Maintenance Access
- Security
- Lighting

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Material Handling and Storage

- Product – within the tool, intrabay, interbay, pass-thrus, stockers, AMHS
- Standard Mechanical interfaces (SMIF)
- WIP philosophy-experiment storage
- Chemicals and Gases – Automatic or manual distribution/collection.
  - Solvents, acids, developer (bases)
  - Specialty Gases.
  - HPM Rooms, corridors

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Summary

The Right Levels of "Clean" for Advanced Technology Environments

Part 1: Asking the Right Questions

- Technology and Research Descriptions
- Nanotechnology Applications
- Defect Issues
- Process Descriptions
- Things to look for
- Can some areas be less clean?
- Substrate Sizes
- Equipment List
- Facility Conditions
- Process Environment
- People Issues
- Material Handling and Storage

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