# Foundations of Semiconductor Manufacturing

## *LAB ACTIVITY: HISTORICAL WAFER INSPECTION AND NODE ANALYSIS*

| Name | Class/Period | Date |
|---|---|---|
|  |  |  |

## 1. Overview

In this lab activity, you will examine uncut silicon wafers from different technological eras. You will perform both macroscopic measurements and microscopic inspections to observe how semiconductor manufacturing has evolved. By comparing wafer diameters and the density of microscopic features, you will visualize the principles of Moore's Law and understand how engineers increase the number of chips produced per wafer.

## 2. Performance Objectives

After completing this lab activity, you will be able to:

- Measure and compare the physical diameter of different silicon wafers.
- Identify structural features on an uncut wafer, including individual dies, scribe lines (streets), and alignment marks.
- Use a digital microscope to compare the relative feature density and interconnect sizing between older and newer technology nodes.
- Explain the economic and technological drivers behind transitioning to larger wafers and smaller nodes.

## 3. Required Materials

The following materials are required to complete this lab activity:

- Assorted uncut silicon wafers from different historical periods (e.g., older 150 mm wafers and newer 200 mm or 300 mm wafers) (2-3 different types per team)
- High-magnification digital microscope (up to 2000X) (1 per team)
- Metric ruler or digital calipers (1 per team)
- Wafer handling tweezers or a vacuum wand (1 per team)
- Cleanroom gloves (1 pair per student)

## 4. Preparation Checklist

Before beginning the lab activity, review this checklist and mark off each item as you complete it.

☐ Cleanroom gloves are worn by all team members to prevent surface contamination.

☐ All hardware components and historical wafers are available at the workstation.

☐ The digital microscope is powered on, focused, and ready for observation.

☐ You have read through the entirety of this document to familiarize yourself with the requirements.

# 5. Lab Activity

## 5.1. Key Terms

Before beginning the inspection, review these key terms:

- **Wafer Diameter**: The physical width of the silicon disc (e.g., 150 mm, 300 mm).
- **Node Size:** The specific manufacturing generation, traditionally referring to the smallest feature size on the chip (e.g., 90 nm, 14 nm).
- **Die:** An individual, repeating integrated circuit pattern on the wafer.
- **Scribe Lines (Streets):** The blank grid spaces between individual dies where the wafer will eventually be cut (diced).

## 5.2. Macroscopic Observation: Wafer Sizing

You and your team will now act as failure analysis technicians documenting incoming components.

Perform the following:

1. Handle the wafers strictly by their edges using the provided tweezers or vacuum wand.
2. Use the metric ruler to measure the diameter of your oldest wafer and your newest wafer. Record the measurements.
3. Observe the individual square or rectangular patterns (the dies) on each wafer.
4. Discuss with your team: Assuming the dies are the same size, how does increasing the wafer diameter impact the total number of chips manufactured in a single batch?

## 5.3. Microscopic Observation: Feature Density and Structure

Perform the following:

1. Place the older technology wafer under the digital microscope.
2. Start at a low magnification to locate the Scribe Lines (streets) dividing the individual dies. Look for tiny, unique geometric patterns embedded in the streets; these are test structures and alignment marks used by engineers during manufacturing.
3. Increase the magnification to observe the surface of a single die. Note the size and spacing of the metallic lines (interconnects).
4. Remove the older wafer and place the newer technology wafer under the microscope at the exact same magnification level.
5. Observe the die surface. Notice how much denser and more tightly packed the metallic interconnect layers appear. This visual difference represents the shrinking of the "node size."

## 6. Authentic Skill Assessment

Have your instructor verify that you have met the requirements for the performance objectives and sign below. Keep this lab activity sheet for future reference.

| Instructor Signature | Date |
|---|---|
| | |