Problem Solving Activity
MEMS Process Problem
Participant Guide

Activity Description

In this activity you apply a systematic approach to problem solving to solve a problem in the photolithography aisle of a microfabrication facility. You and your team have been directed to solve the problem and fix it. You are to use the six-steps of problem solving to identify the cause of this problem, develop an action plan on how to fix it, and develop the plan to verify that the problem has been fixed.

You will be evaluated on how well you apply a systematic approach to solving the problem, how wel you communicate with your team members and those from which you gather information (your instructor), and how well you work together as a team.

<u>Time to Complete</u>
Approximately 45 minutes

Objectives

- Given a microfabrication problem, work with at least two other people to solve the problem using a six-step approach to problem solving.
- Develop an action plan that fixes the problem.
- Apply effective communication skills through the entire problem solving process.

Activity – MEMS Process Problem

1. Assign the following roles:
    a. Recorder - Writes necessary information on the board, flip chart or computer screen for all to see and keeps a written accounting of the team's process. Recorder is also a participant in the problem solving process.
    b. Facilitator – Keeps the team members on track during the activity and the activity moving forward. Mediates the exchange of information and ensures that all team members participate and understands before moving forward. The facilitator is also a participant; however, the facilitator has to be able to ensure that ALL participants participate and should be careful not to dominate nor control the conversation. An effective facilitator usually waits to contribute until all other participants have contributed. Choose this person wisely.

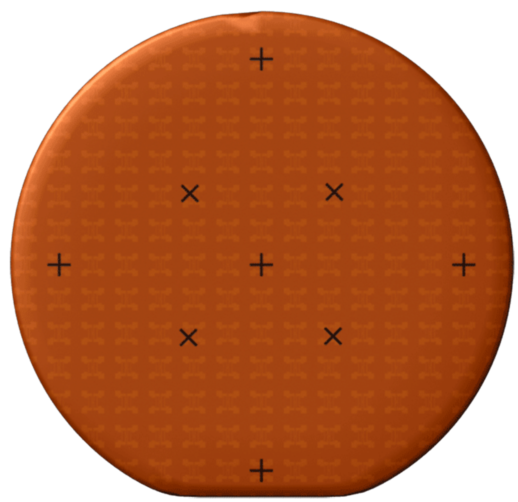
2. The team – The team consists of employees with different roles from within photolithography (e.g., an engineer, technician, supervisor). However, your job title is not important within the team, but what you know about the process, equipment, and other aspects of the business are important. Within the team you work equally and together to solve the problem.
3. The Problem – A photolithography technician has reported that, after randomly testing several wafers from the last processed batch and plotting the results on the control chart, the resist thickness of this batch of wafers is out-of-control (OOC). The technician consulted the Out-of-Control Action Plan (OCAP) which told her to run another batch of wafers and retest. After retesting she found that the resist thickness was still OOC.

   NOTE: *The OCAP is an action plan that technicians are required to following when an OOC situation is identified. This is the first step that a technician makes. If, after following the OCAP, the process is still OOC, then the problem might require a problem solving team, which is the case presented here.*

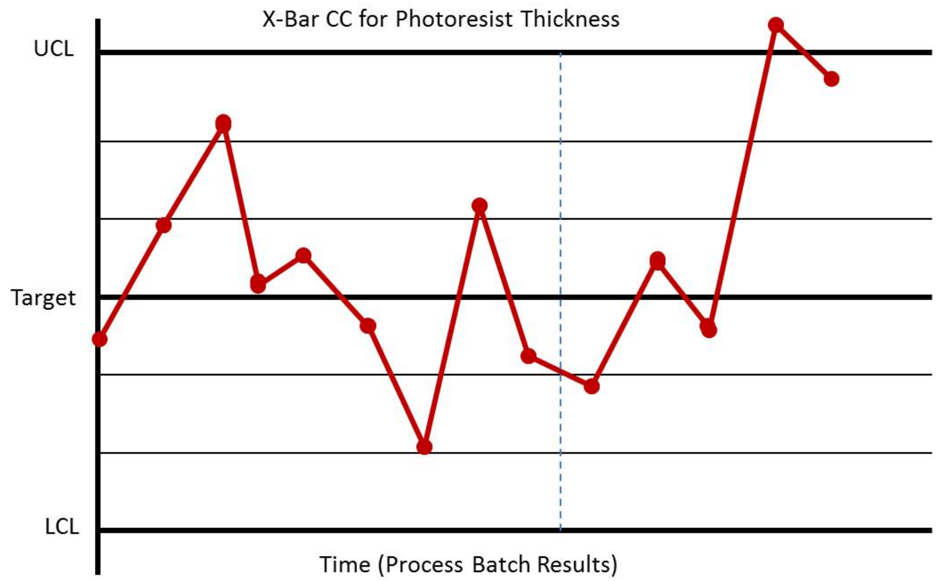
   Following is the company's quality control (QC) procedure for measuring photoresist thickness and uniformity. After the QC procedure are the current control charts for photoresist thickness (x-bar chart) and uniformity (R-chart).

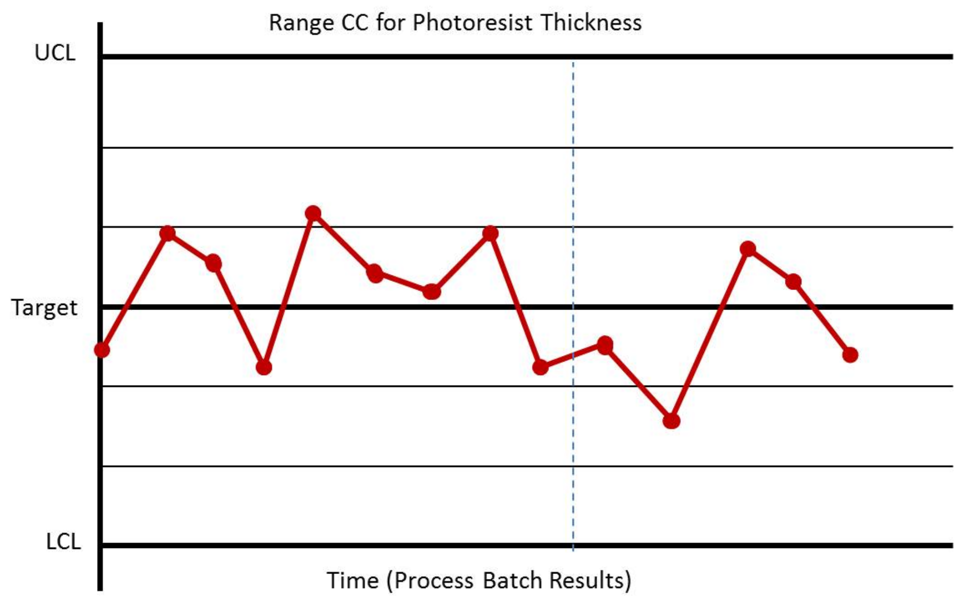
Company's Quality Control Check Procedure

The quality control procedure for resist thickness and uniformity is to randomly select 5 wafers from each processed batch of 24 wafers, and measure the photoresist thickness at 9 points on the wafer. This diagram illustrates those nine points. The *mean* resist thickness for all measurements is calculating and plotted on an x-bar control chart. The mean *range* of thicknesses for the 5 wafers is calculated and plotted on the R control chart.

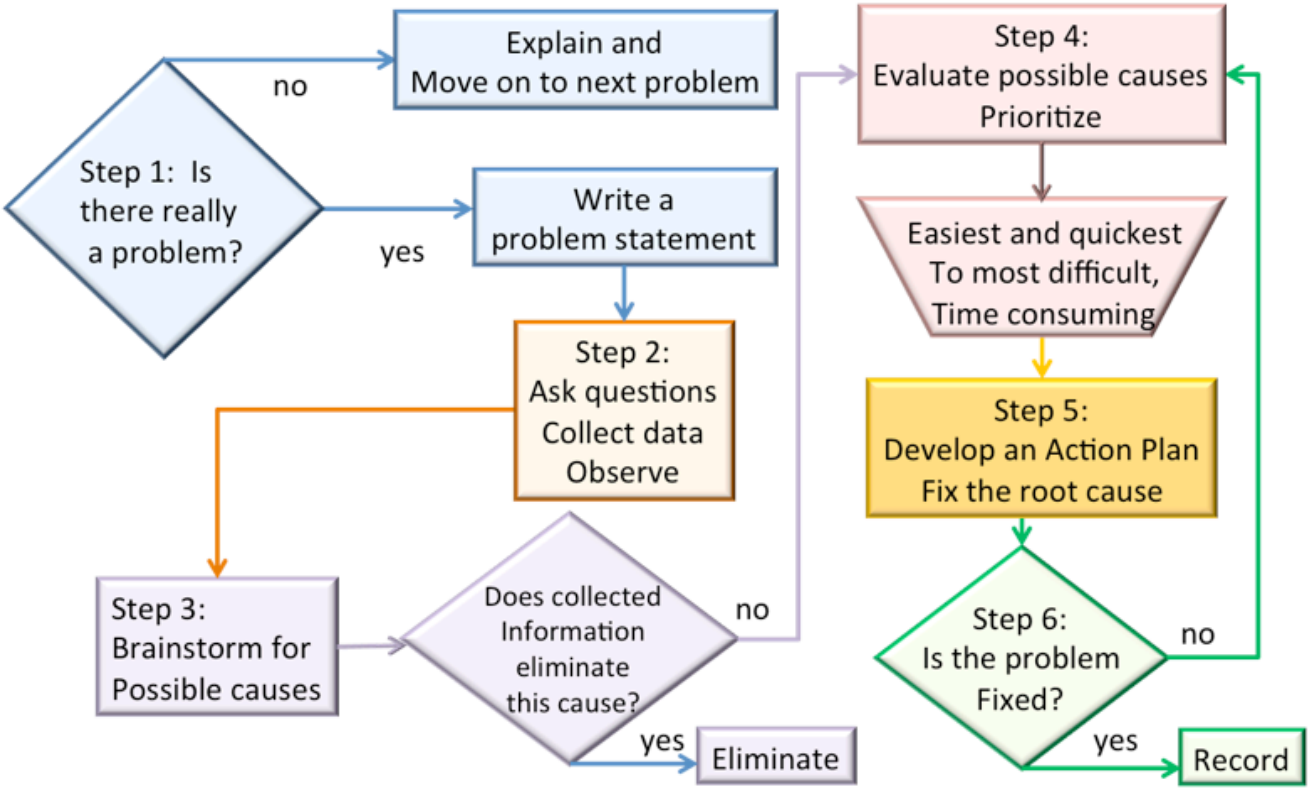


Below are the x-bar and R control charts for photoresist thickness for the last 14 batches of wafers. (**Dashed line indicates shift change**.)





As a team, you are to use the Six Steps of Problem Solving to solve this problem. Direct all analysis and evaluation questions to your instructor.



Let's get started!

Step 1: *Write the problem statement*. Make sure that the whole team agrees with the problem statement before moving forward.

Step 2: *Analyze the problem:* Make a list of questions that you would ask other employees that might know more about the problem, as well as a list of data or other information that you need to know more about the problem. Make sure that any requests or questions are relevant to the problem and in helping to solve the problem. Be sure to word your questions in a manner that yields the most information.

Step 3: Brainstorm for possible causes to the problem. Record your results on a C&E diagram.

Step 4: Analyze the possible causes and identify the root cause of the problem. Use the data that you have already collected to eliminate some of the items on your C&E. If you need additional information, submit another set of questions and request for more information to your instructor. You

Step 5: Develop an action plan on how to fix the problem. At this point you should be confident that you know the cause of the problem. Now it's time to fix it. You may find that there are several ways to fix this problem. As a team, discuss the possibilities and develop an action plan for the most effective and efficient solution to the problem.

Step 6: State how you will verify that the problem has been fixed.

Present your action plans for Step 5 and Step 6 to the instructor and to other teams. Compare the plans of the different teams and discuss the differences.

Post-Activity Questions

Below are the objectives of this activity.

- Given a microfabrication problem, work with at least two other people to solve the problem using a six-step approach to problem solving.
- Develop an action plan that fixes the problem.
- Apply effective communication skills through the entire problem solving process.

Answer the following questions based on how well you satisfied the objectives.

1. How easy/hard was it to following a systematic approach for solving this problem?
2. Take a look at the questions you developed in Step 2 and identify what you would consider a "weak" question and a "strong" question. Which one of your questions was "weak"? What was one of your "strong" questions? How could the team have improved upon the questions they asked?
3. When selecting and analyzing the "data", what criteria did you use to determine what was relevant and what was NOT relevant to the problem?
4. What criteria did you use in developing your action plan?
5. As a team, what were your strengths?
6. As a team, what areas could be improved upon?
7. What behaviors helped the team to complete its task?
8. What behaviors hindered the team from completing its task?

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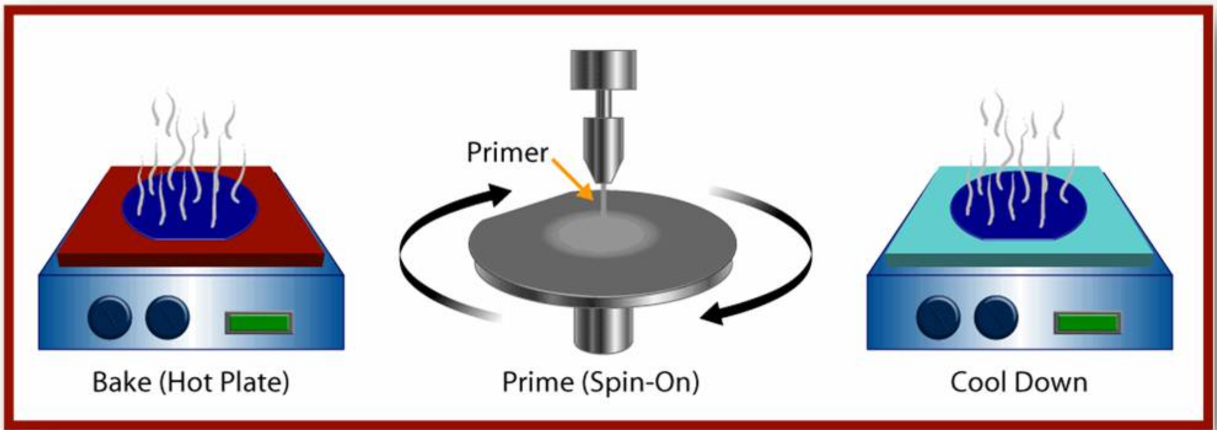
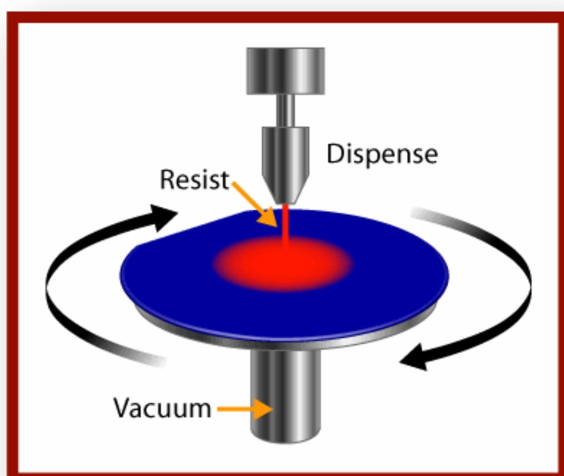
Review of Photoresist Process

Prior to applying the photoresist, the wafer is conditioned. It is heated to remove any surface moisture, then a layer of HMDS (hexamethyldisilazone) is spun on the surface of the wafer to act as a primer for the photoresist. After the HMDS is applied to wafer, the wafer is cooled prior to applying the photoresist.



Below (left) is a spin coat chamber for applying photoresist (resist) to the surface of a wafer. The wafer sits on a wafer chuck through which a vacuum is applied. The vacuum holds the wafer on the surface of the chuck keeping it from flying off during the spin coat process. Depending on the program, the resist can be deposited onto the center of the wafer prior to the wafer starting to spin or immediately after the wafer starts to spin. Once the resist is deposited, the speed accelerates to its casting speed (the final spin speed).



After conditioning, the photoresist is applied
followed by a softbake to remove residual solvents from the photoresist. After the softbake then wafer is cooled.