Lithographic Optimization: A Theoretical Approach
(1 day class)

1. Aerial Image

1.1. Imaging Review

Purpose: The purpose of this section is to provide a basic review of projection imaging.
Objectives: Upon completion of this section, you will be able to:
- Describe the principle of diffraction
- Define numerical aperture
- Describe how a basic imaging system works

1.2. Image Quality Metrics

Purpose: The purpose of this section is to define an appropriate metric for image quality and demonstrate its use.
Objectives: Upon completion of this section, you will be able to:
- Explain the problems with image contrast
- Define the image log-slope and the NILS
- Explain the importance of the log-slope defocus curve

1.3. Using the Image Log-Slope

Purpose: The purpose of this section is to demonstrate the use of the image log-slope for optimizing lithographic imaging.
Objectives: Upon completion of this section, you will be able to:
- Explain how NA and wavelength affect image quality
- Use the log-slope to optimize NA and sigma

2. Exposure Optimization

2.1. Latent Image Gradient

Purpose: The purpose of this section is to define the latent image gradient and describe its relationship to the image log-slope.
Objectives: Upon completion of this section, you will be able to:
- Define the latent image gradient
- Understand how the latent image gradient relates to the image log-slope

2.2. Optimum Exposure

Purpose: The purpose of this section is to show how the use of the latent image gradient leads to an optimum exposure dose.
Objectives: Upon completion of this section, you will be able to:
- Explain why there exists an optimum exposure dose
- Understand the built-in contrast enhancement effect of photoresist bleaching

3. Development Optimization

3.1. Theoretical Contrast

Purpose: The purpose of this section is to define the theoretical contrast and explain its use.

Objectives: Upon completion of this section, you will be able to:
- Understand the problems with conventional contrast measurement techniques
- Define the theoretical contrast and explain why it is important

3.2. Development Path

Purpose: The purpose of this section is to show how the development path affects resist profile formation.

Objectives: Upon completion of this section, you will be able to:
- Understand the nature of the development path
- Explain what controls photoresist sidewall angle

4. Linewidth Control

4.1. Overview

Purpose: The purpose of this section is to review the basic factors affecting linewidth control.

Objectives: Upon completion of this section, you will be able to:
- Describe the two approaches for improving linewidth control
- Understand the limitations linearizing the problem

4.2. Focus Exposure Matrix

Purpose: The purpose of this section is to describe the use of the focus-exposure matrix towards defining depth of focus and resolution.

Objectives: Upon completion of this section, you will be able to:
- Understand the importance of the focus-exposure matrix
- Define depth of focus
- Define resolution
- Explain the nature of asymmetric focus responses

4.3. Mask Error Enhancement Factor

Purpose: The purpose of this section is to define and understand the Mask Error Enhancement Factor (MEEF).

Objectives: Upon completion of this section, you will be able to:
- Define the MEEF
- Understand the basic causes and implications of a non-unit value of the MEEF