

Resolution Enhancement Technologies for Optical Lithography (1 day class)

1. Resolution

1.1. Defining Resolution

Purpose: The purpose of this section is to define what is meant by resolution and determine the main variables that affect resolution.

Objectives: Upon completion of this section, you will be able to:

- Define Resolution using the simple Rayleigh criterion
- Define true manufacturing resolution
- Understand the difference between pitch and feature resolution

1.2. Why is Lithography Hard?

Purpose: The purpose of this section is to provide a broad overview of the goals and challenges of optical lithography.

Objectives: Upon completion of this section, you will be able to:

- Describe the five basic approaches for improving resolution
- Understand why resolution enhancement technologies are used

2. Resolution Enhancement

2.1. Off-Axis Illumination

Purpose: The purpose of this section is to describe off-axis illumination and its impact on resolution and depth of focus.

Objectives: Upon completion of this section, you will be able to:

- Describe how off-axis illumination can improve resolution
- Describe how off-axis illumination can affect depth of focus
- Define “forbidden pitch”
- Design an off-axis illuminator for a given pitch

2.2. Phase Shifting Masks

Purpose: The purpose of this section is to describe phase shifting masks and their impact on resolution and depth of focus.

Objectives: Upon completion of this section, you will be able to:

- Describe how phase shifting masks can improve resolution
- Describe how phase shifting masks can improve depth of focus
- Understand the sources and resolutions of phase conflicts and phase and intensity imbalance

2.3. Optical Proximity Correction

Purpose: The purpose of this section is to define and understand optical proximity effects and their correction.

- Objectives: Upon completion of this section, you will be able to:
- Explain the origins of proximity effects
 - Describe the three basic approaches to optical proximity correction
 - Understand the advantages and the difficulties of SRAFs

2.4. Polarization

Purpose: The purpose of this section is to understand polarization and why one polarization state degrades image quality, while the other does not.

- Objectives: Upon completion of this section, you will be able to:
- Explain the difference between TE and TM polarization
 - Understand which polarization is “good” and which is “bad”

2.5. Immersion Lithography

Purpose: The purpose of this section is to understand immersion lithography and its impact on resolution and DOF.

- Objectives: Upon completion of this section, you will be able to:
- Define the Optical Invariant
 - Understand how immersion affects the Rayleigh resolution and depth of focus equations