

EUVL ML Blank Fiducial Mark Generation via Local Heating

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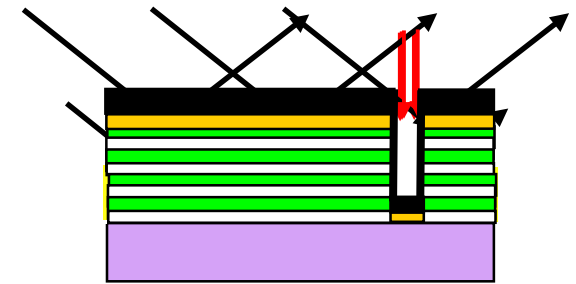
Outline

- Introduction
- Concept of Heating Generated Fiducial Marks on ML
- Experiment conditions and setup
- Experimental results and discussions
 - Fiducial mark characterization
 - Fiducial mask detectability under the different inspection tools
- Conclusions

Introduction

● Proposed EUVL Mask Blank Fabrication Process Flow

- Substrate polishing
- Substrate clean
- Substrate defect inspection and qualification
- ML deposition (assume is a clean process)
- Fiducial mark generation (clean process)
- ML defect inspection and qualification
- Buffer absorber layer deposition



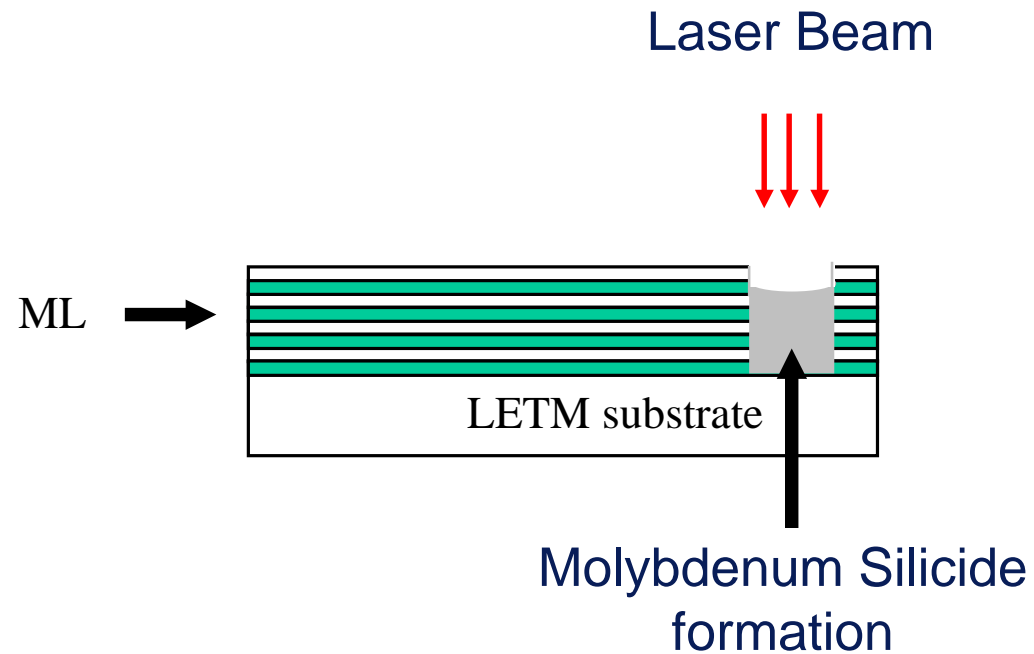
● It is not necessary to have the fiducial mark at the substrate

● Fiducial mark at ML will serve as alignment mark for identify ML defect locations

Introduction (cont'd)

- **With ML fidutail mark and a few ML defects, defect can be aligned and located for defect mitigation schemes**
 - Using absorber pattern to cover ML defects
 - ML defect proximity repair after patterning
 - Possible ML defect repair

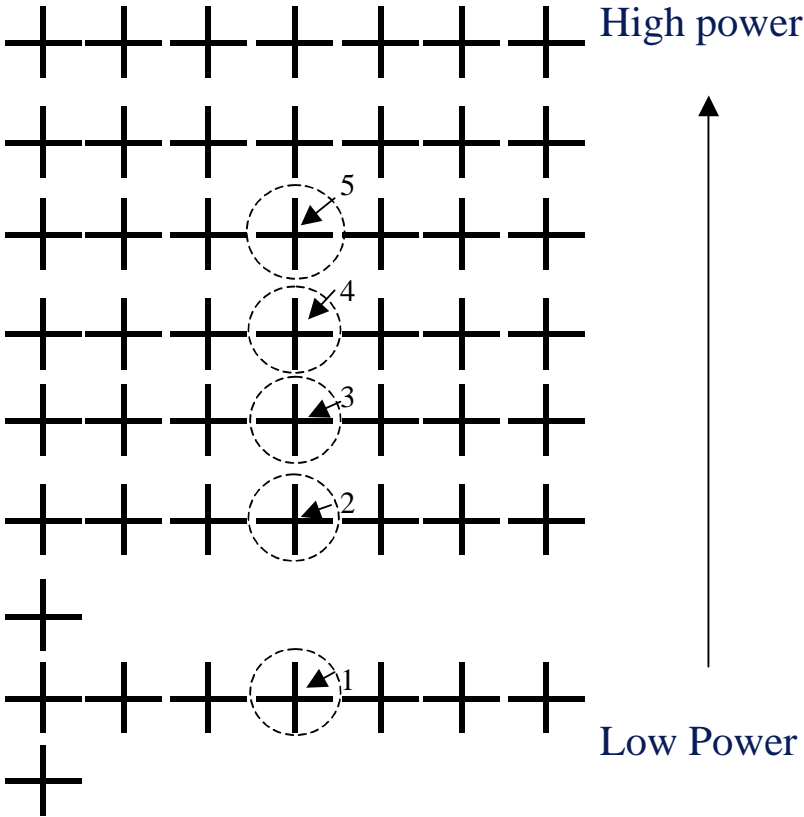
Concept of Heating Generated Fiducial Mark in EUVL ML Blanks



- ✓ Molybdenum Silicide has less volume than that of Mo/Si ML. Trench or mark generated with no material removal – a clean process

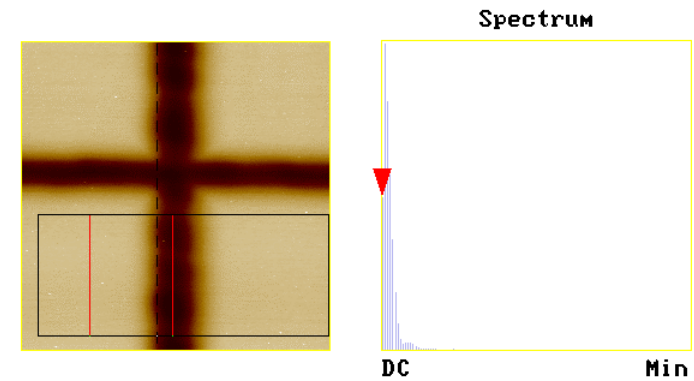
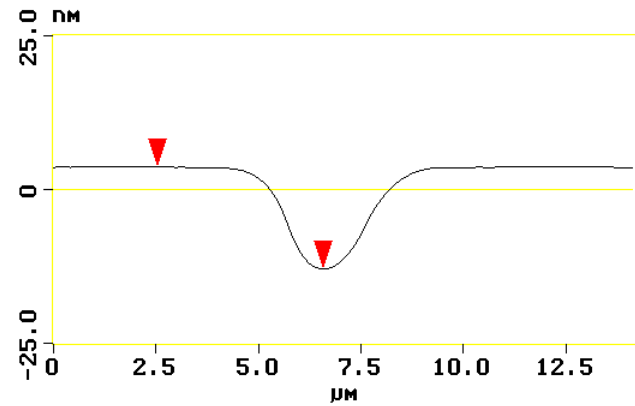
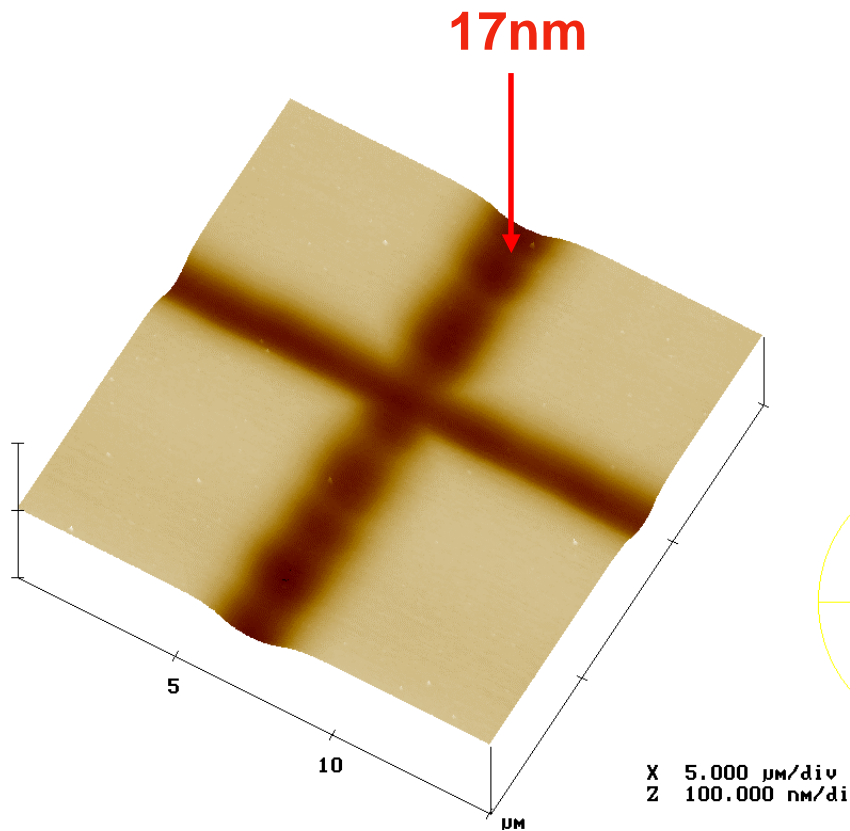
Experimental Setup

- 49 laser energies are used in the experiment with constant increment



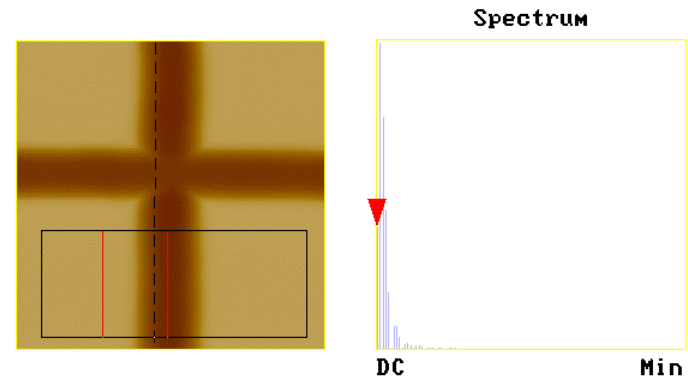
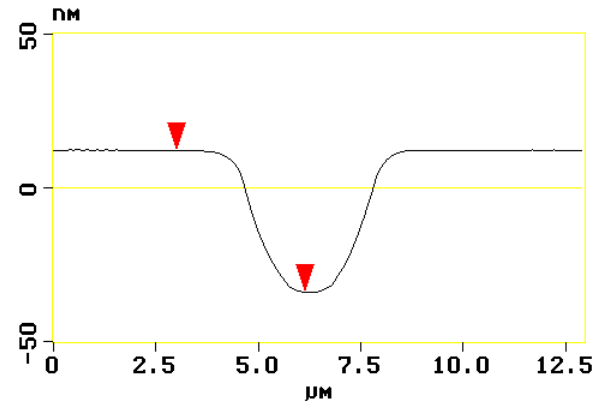
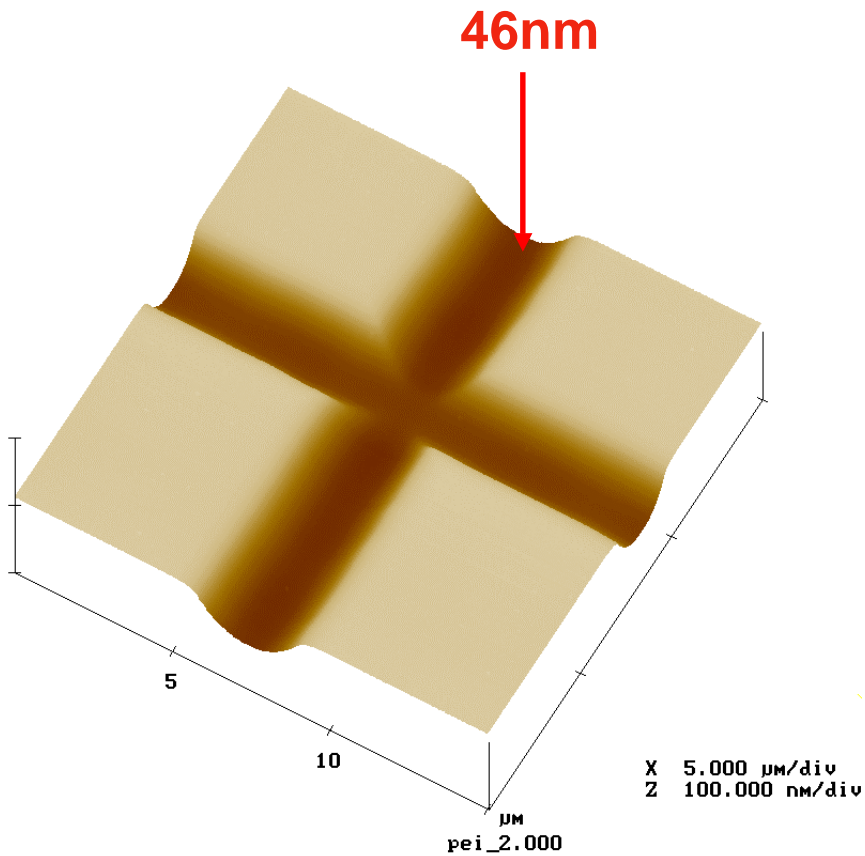
Results:

Fiducial Mark Generated with Laser Power Level 1 Power level 1-5 (low to high)



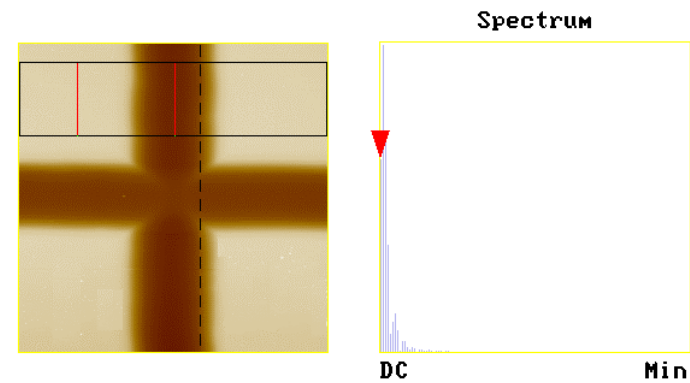
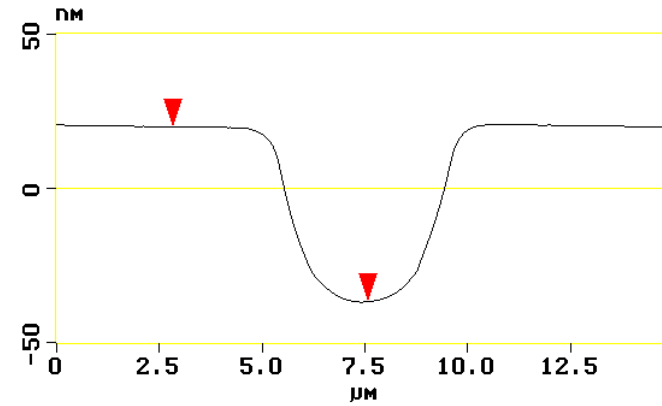
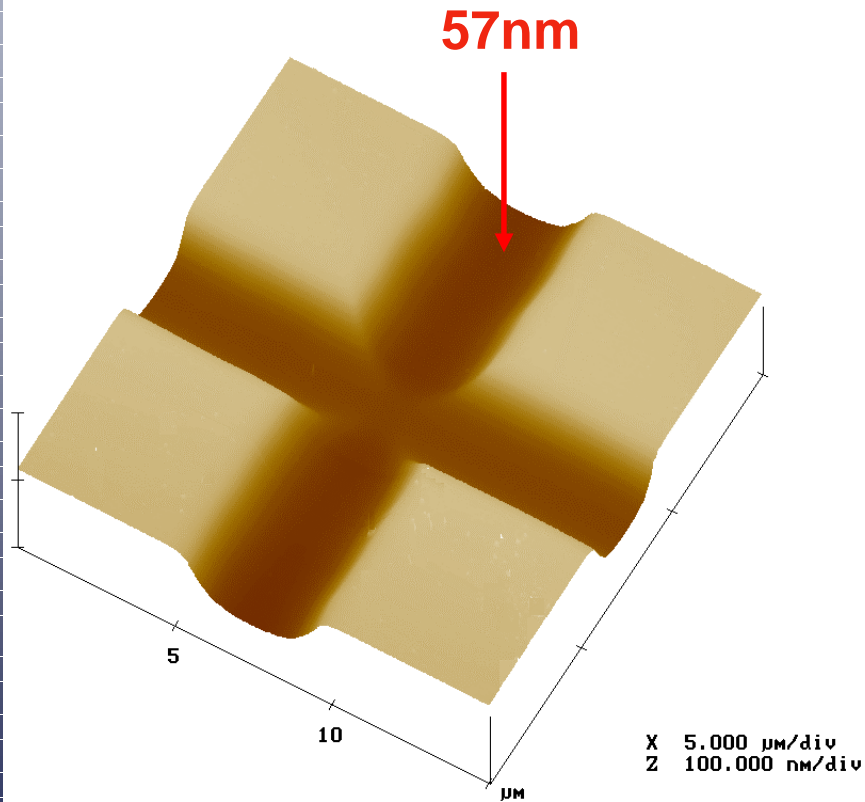
Fiducial Mark Generated with Laser Power Level 2

Power level 1-5 (low to high)



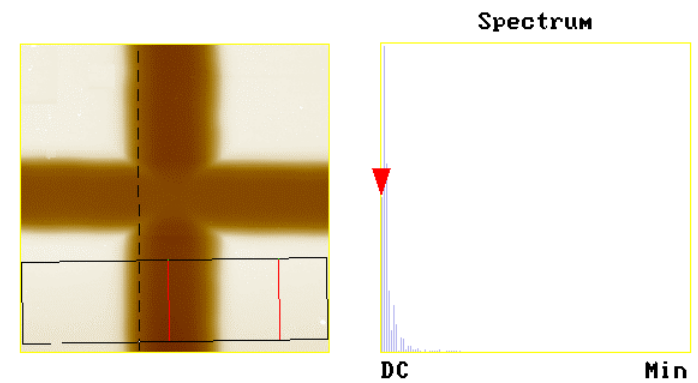
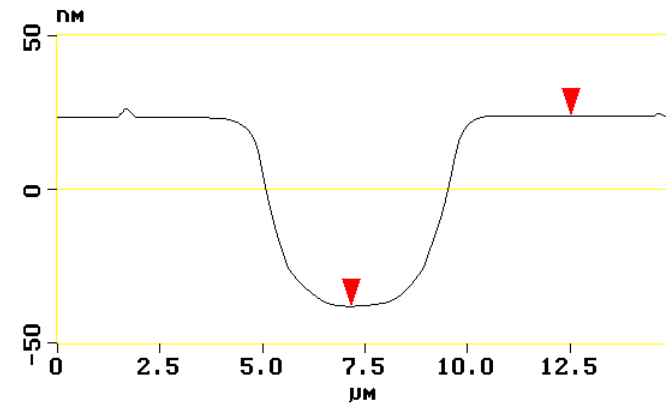
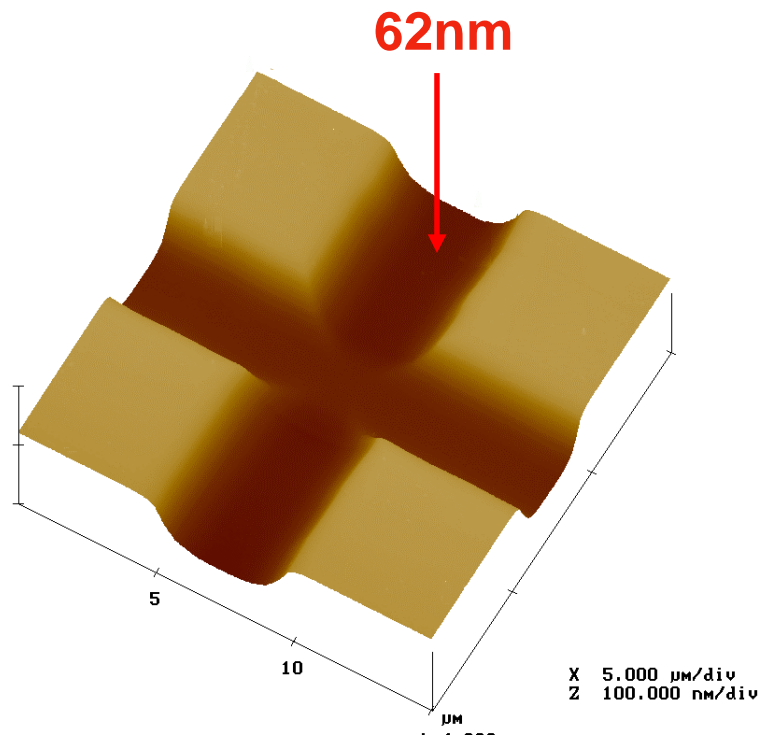
Fiducial Mark Generated with Laser Power Level 3

Power levels 1-5 (low to high)



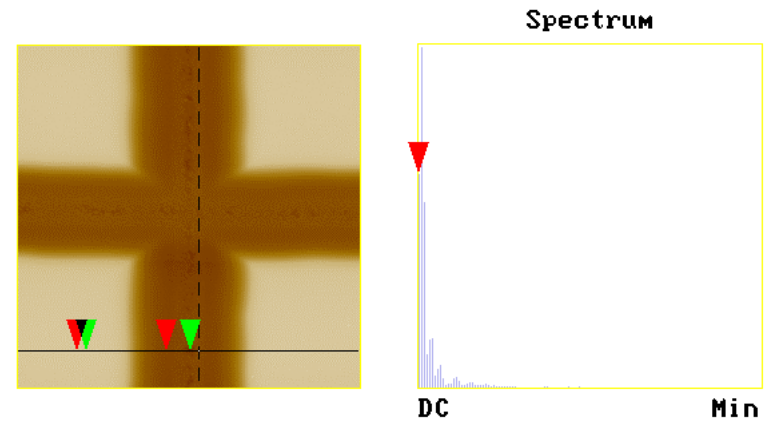
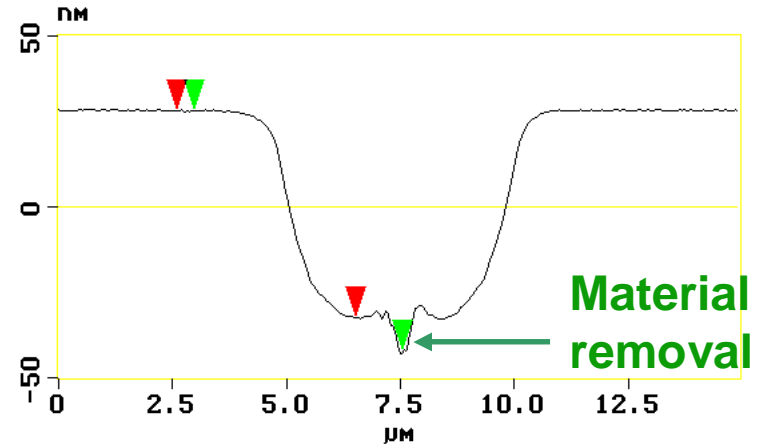
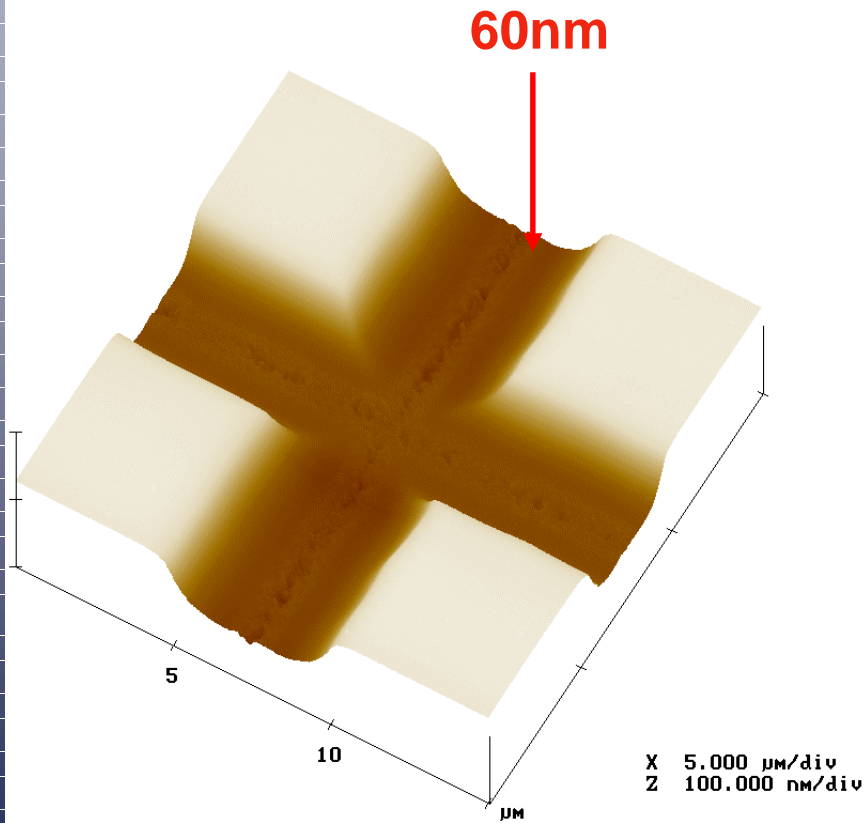
Fiducial Mark Generated with Laser Power Level 4

Power level 1-5 (low to high)

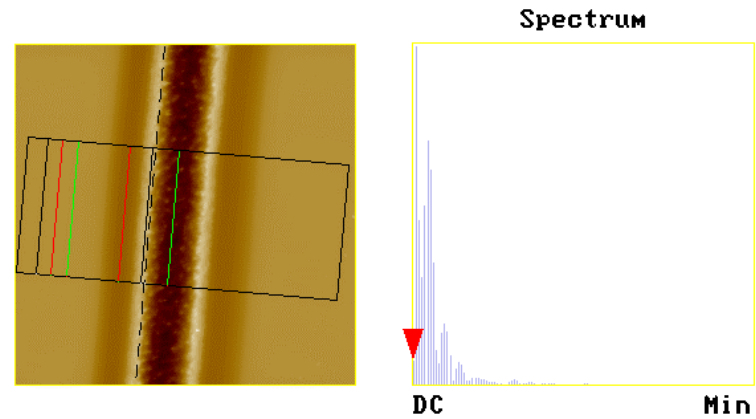
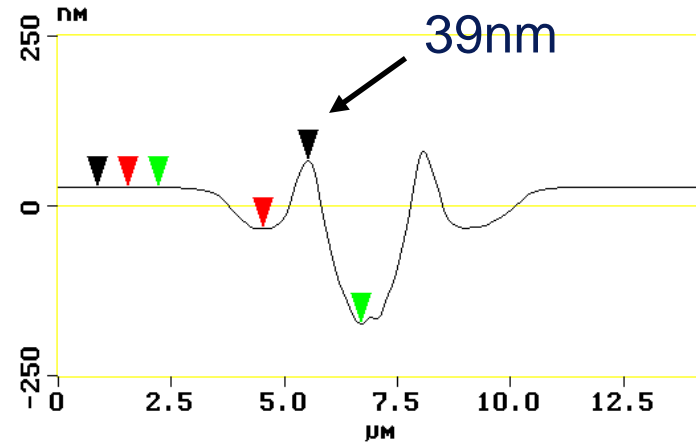
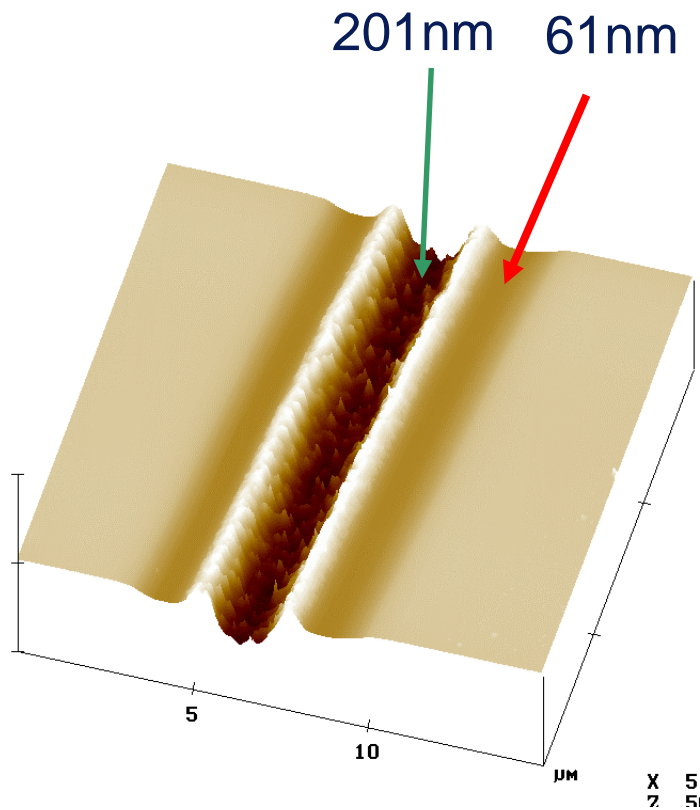


Fiducial Mark Generated with Laser Power Level 5

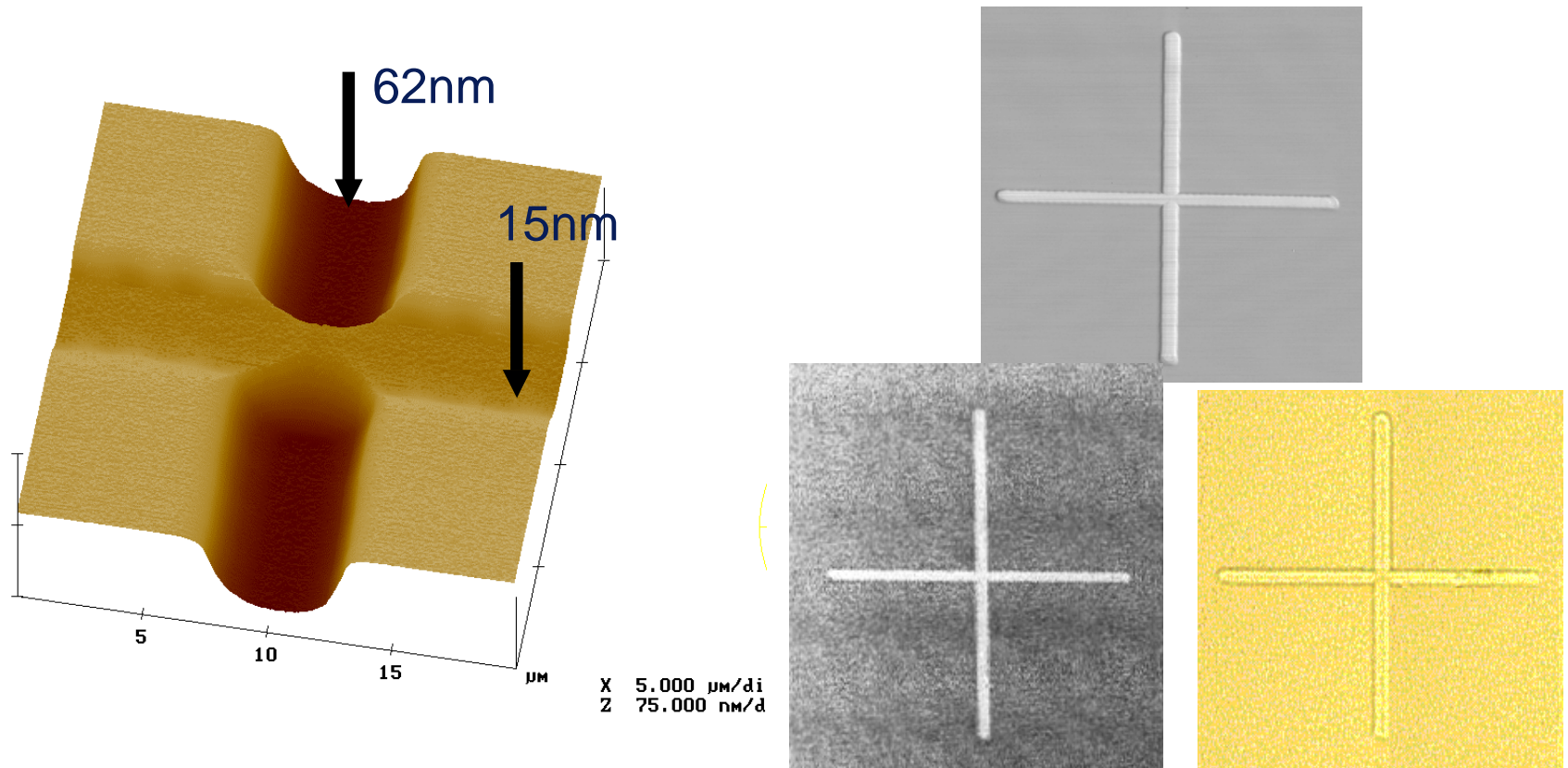
Power level 1-5 (low to high)



Fiducial Mark Generated with High Laser Power

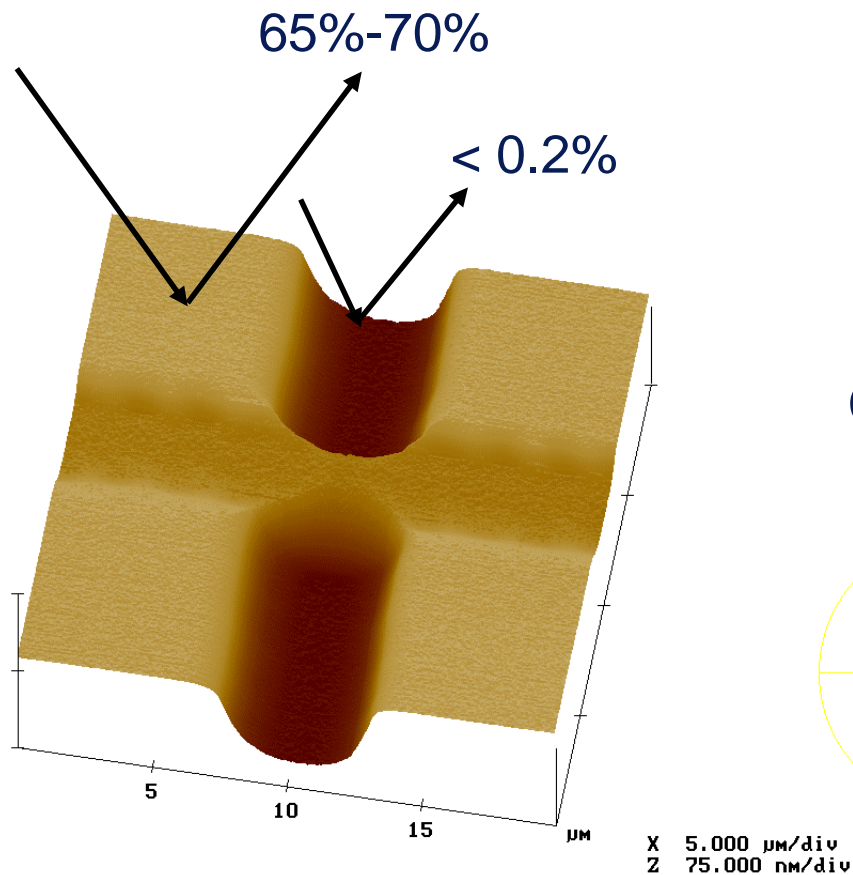


Fiducial Mask Detectability Under the Different Inspection Tools



- ✓ Slope of the trench plays insignificant role in inspection image contrast
- ✓ Depth of the trench (>15nm) plays insignificant role in inspection image contrast

High Inspection Contrast Also in EUV AMIS



$$\text{Contrast} = \frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}} > 99\%$$

Conclusions

- **EUVL ML mask blank fiducial mark can be generated with no material removal**
 - **Maximum mark depth ~60nm (40 Mo/Si ML pairs)**
 - **Good trench profiles**
 - **Clean process**
- **High inspection image contrast observed in different inspection tools, especially in MCI system**
 - **Insensitive to mark profile slopes**
 - **Insensitive to mark depth (for depth >15nm)**
- **Larger process margin for laser power control**
 - **Can tolerate at least +/-12.5% energy variation from its nominal**

Acknowledgement

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