



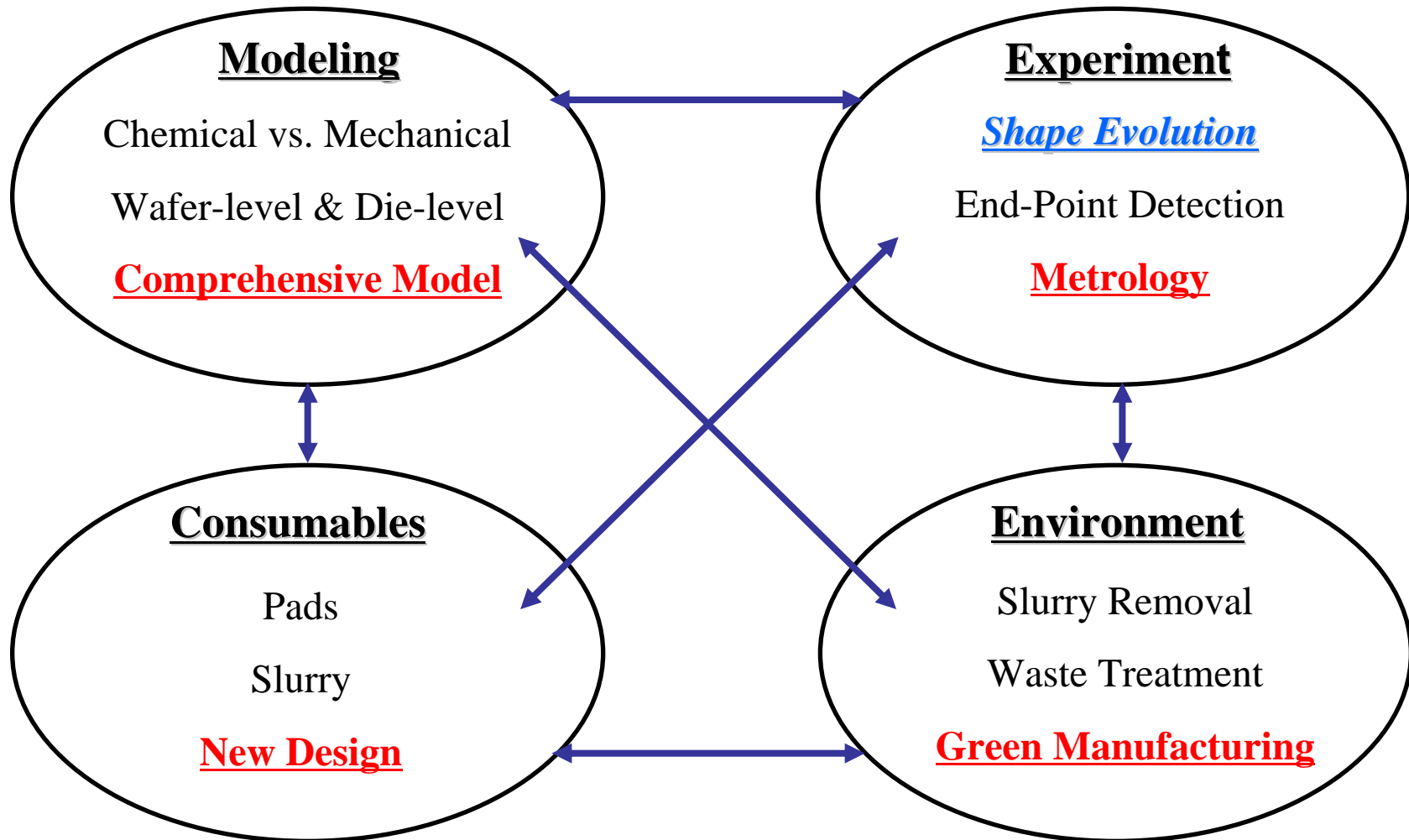
The Orientation Effects in Shape Evolution in CMP

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CMP User Groups



Dornfeld Research Group



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Overview

- **Motivations**
- **Pattern-Density Dependency Model**
- **Orientation Effects**
- **Experimental Results**
- **Analysis**
- **Conclusions**
- **Future Work**

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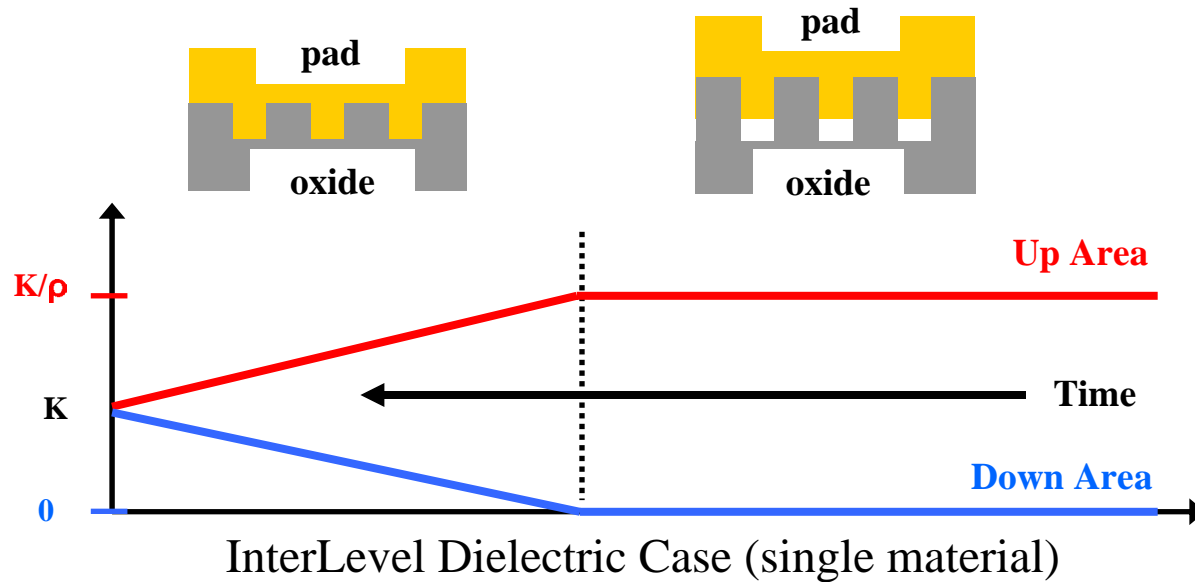
Motivations

Make finer distinctions in the **pattern-density dependency model** in order to address ever-decreasing dimensions and ever-increasing complexity of layer pattern, specifically, by introducing the “**ORIENTATION EFFECTS**” concept.

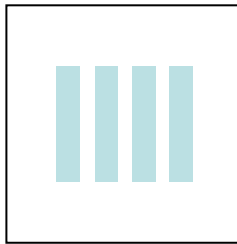
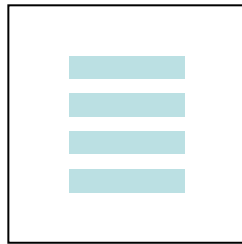
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Pattern-Density Dependency Model



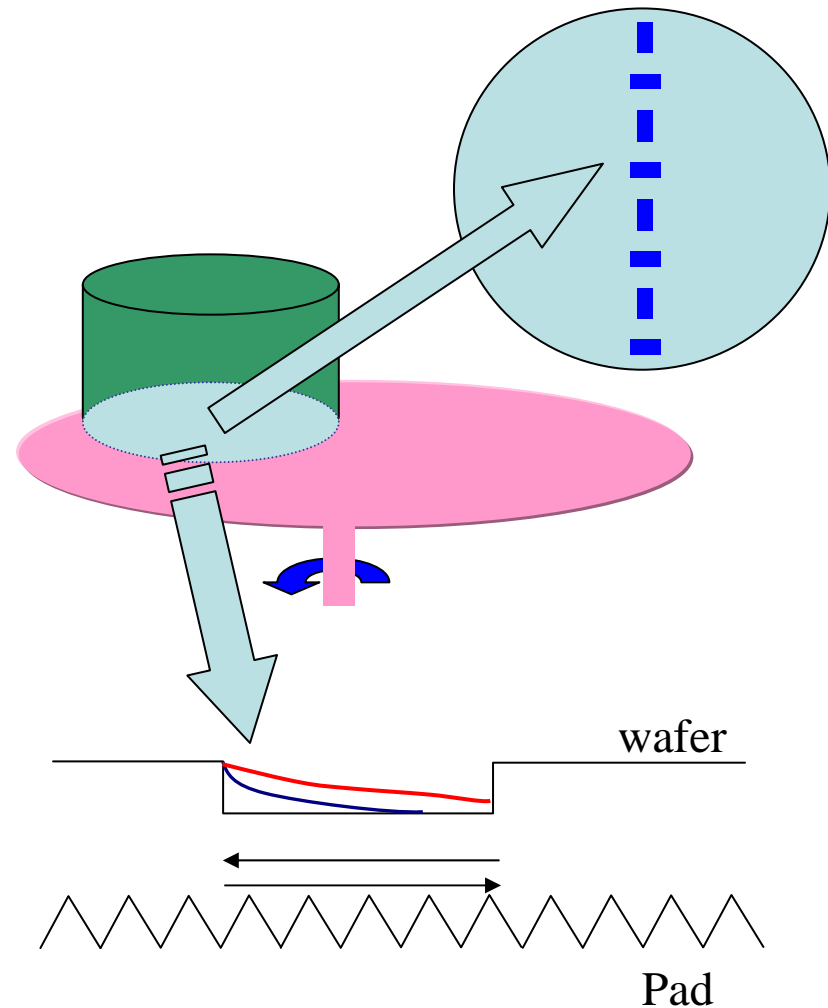
Courtesy: MIT



Same Pattern Density
Different Orientations

Orientation Effects

- Polish “UNI”- directionally
 - stop rotating the wafer
 - go across a feature
- Isolated bar features
 - placed in both radial and tangential orientations
 - enough spacing to prevent proximity effect

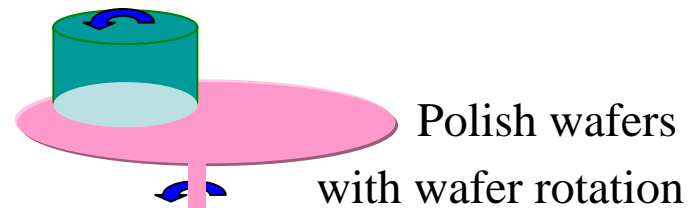
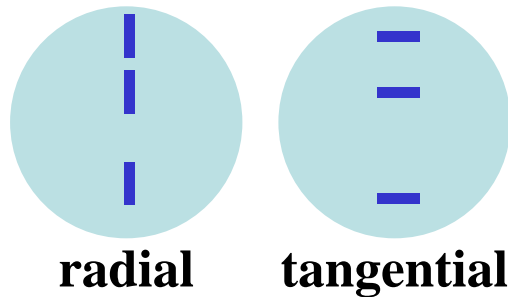


Approach

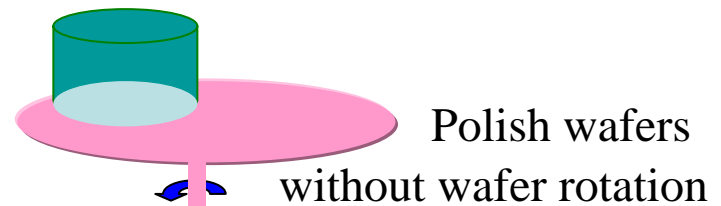
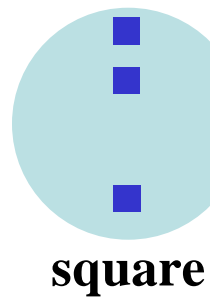
- 3 different features

- 2 different modes

1D features

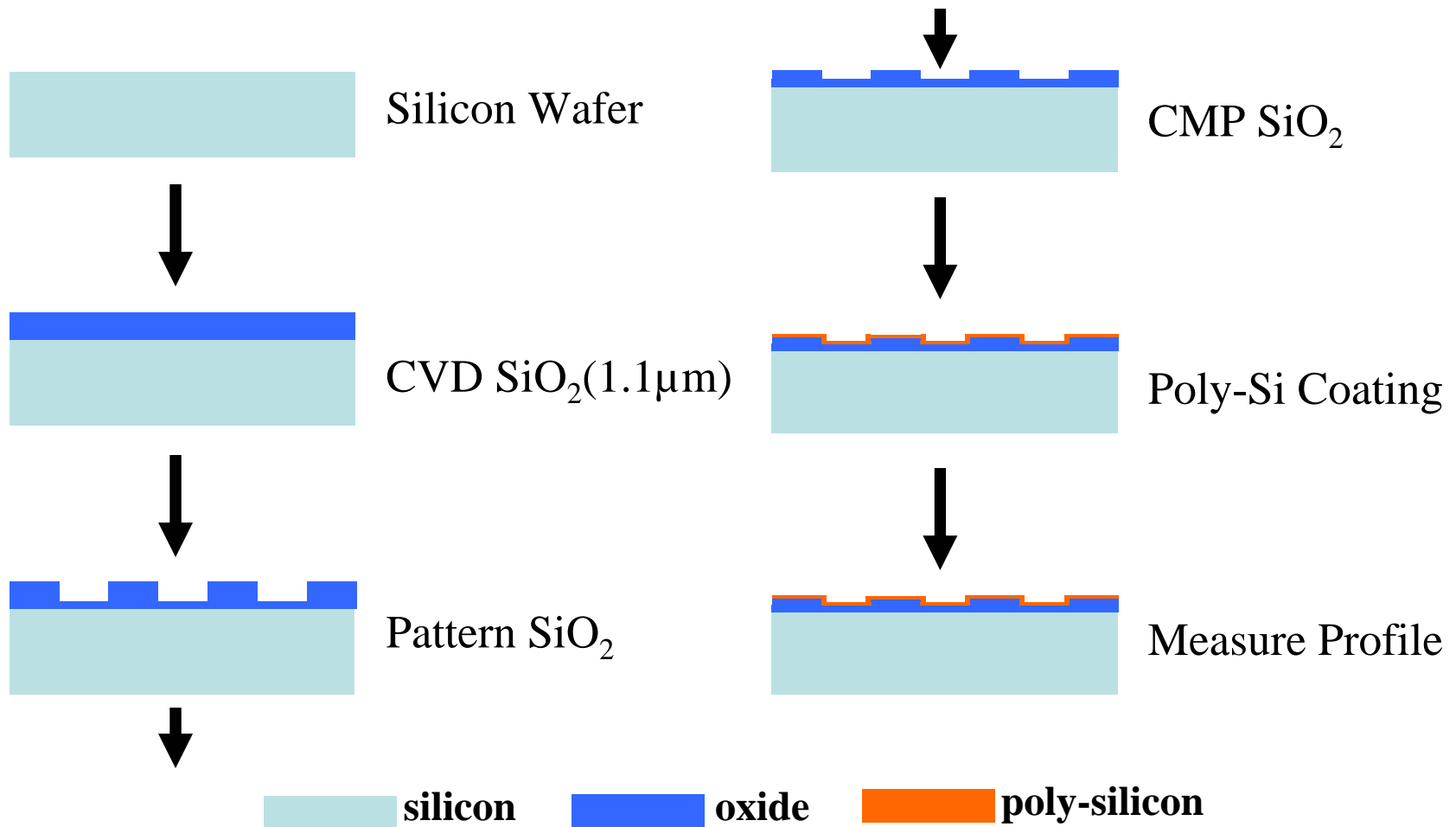


2D features



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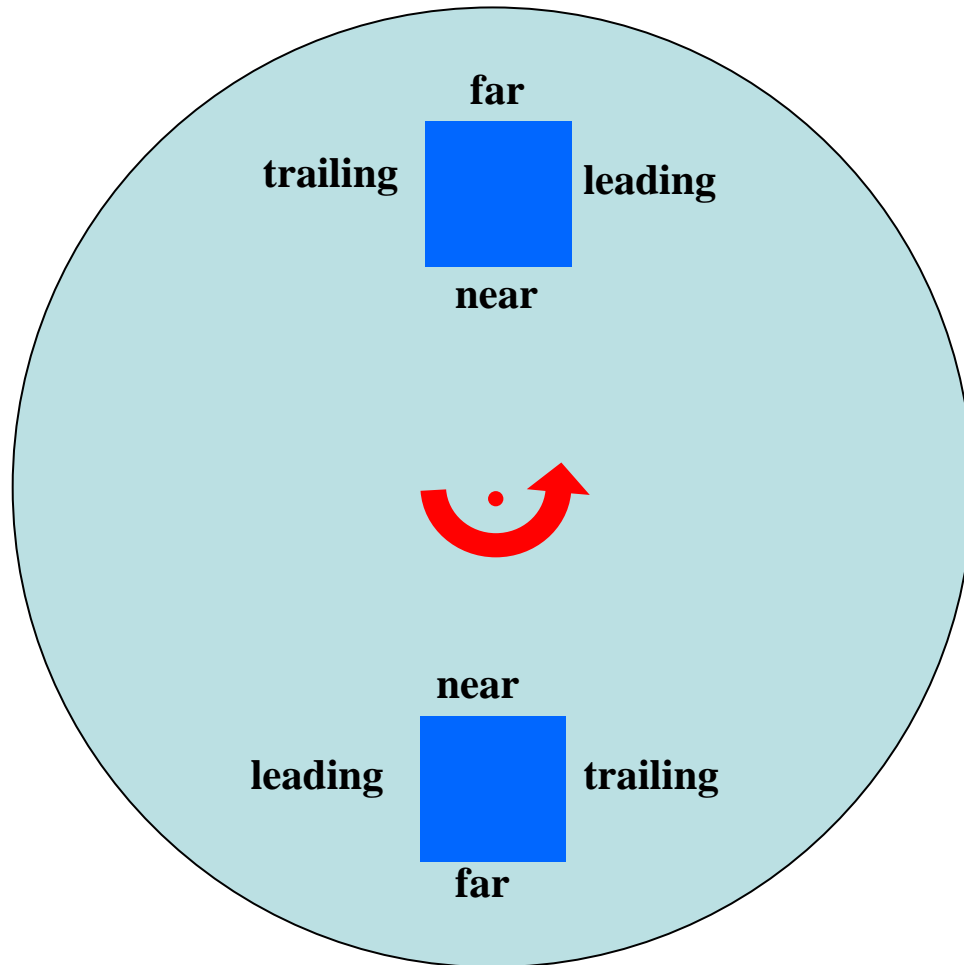
Process Flow



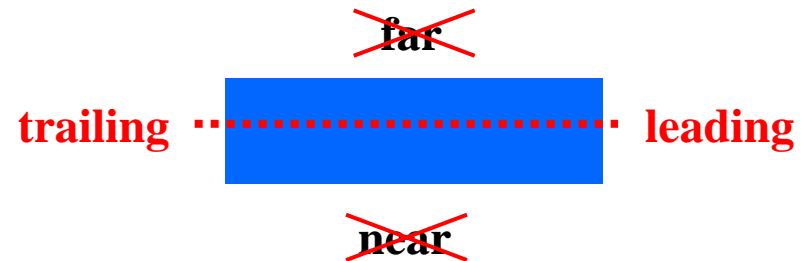
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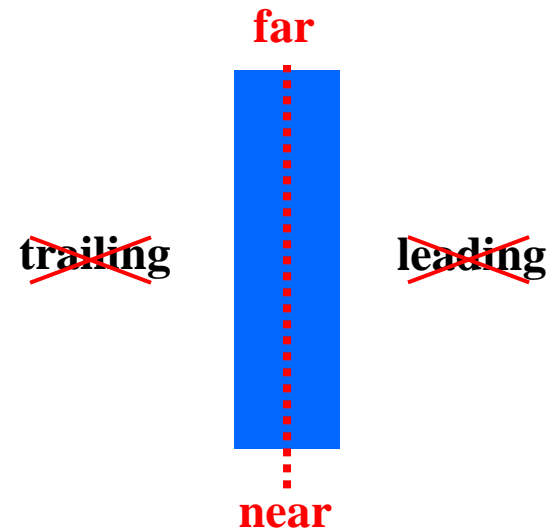
Definition of Geometries



- Radial features

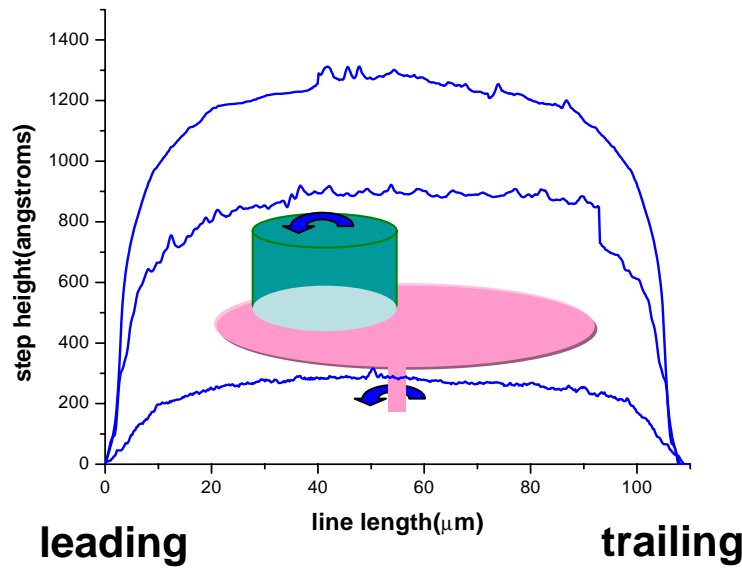


- Tangential features

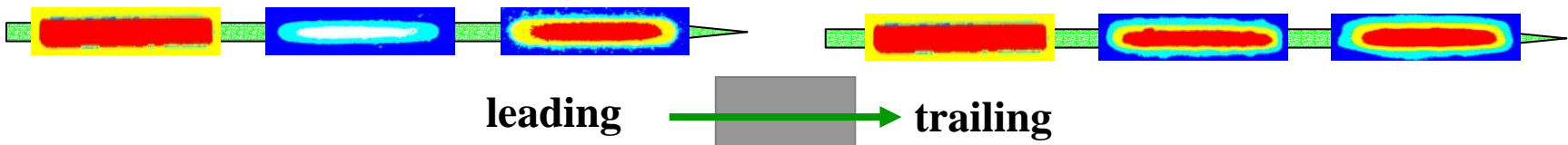
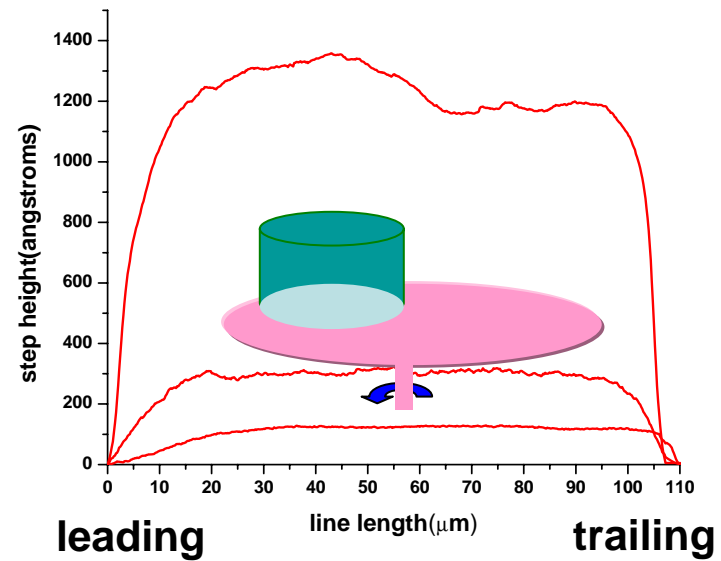


Experimental Result – Tangential features

Wafer rotation



No wafer rotation

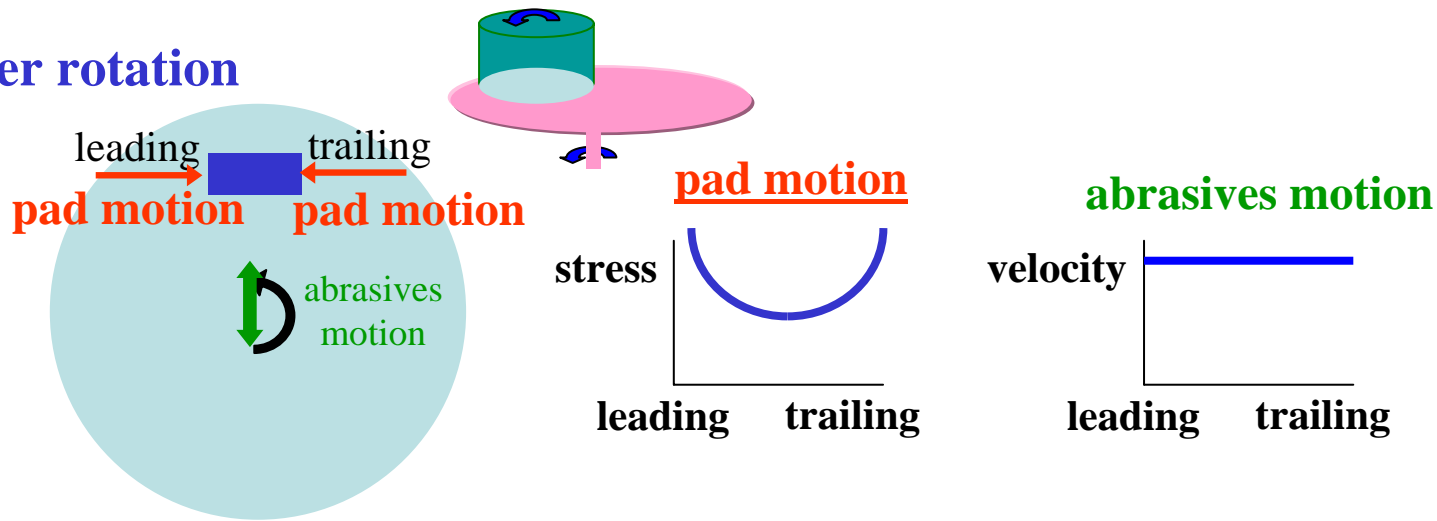


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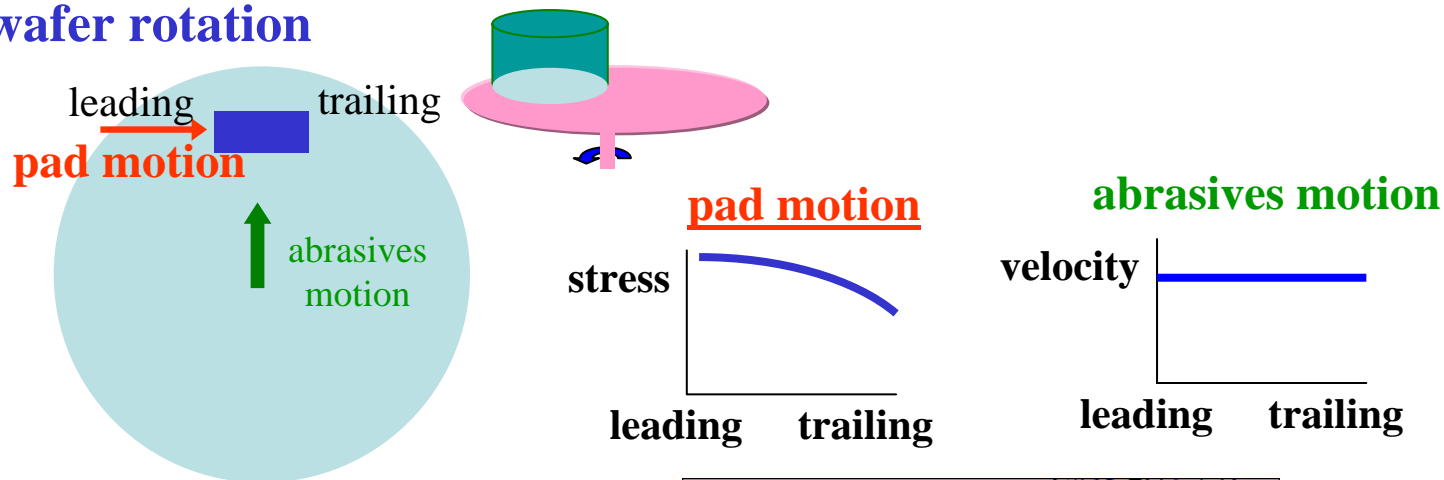


Analysis – Tangential features

Wafer rotation



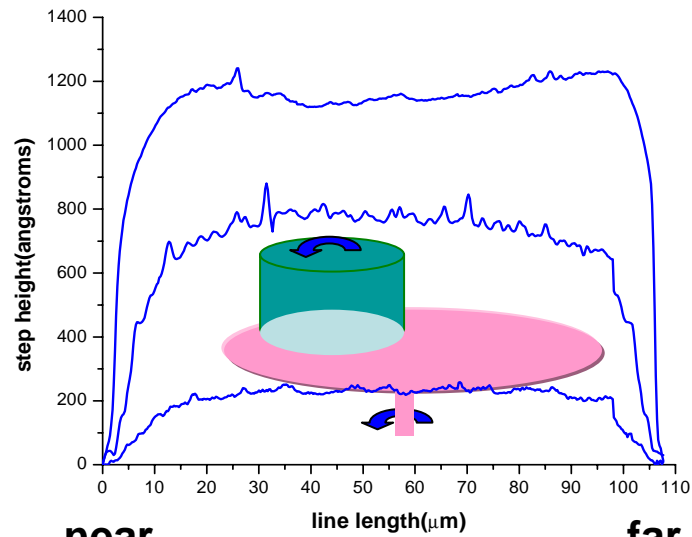
No wafer rotation



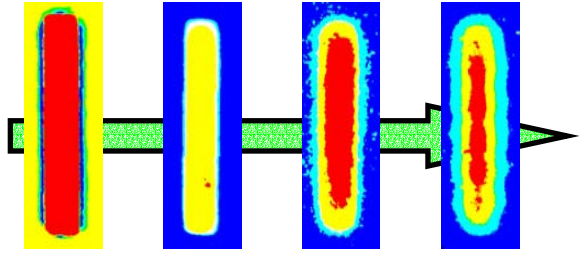
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Experimental Result – Radial features

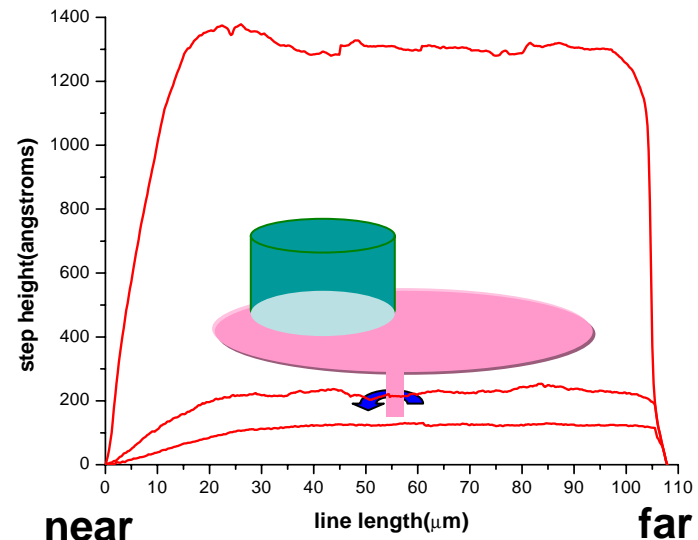
Wafer rotation



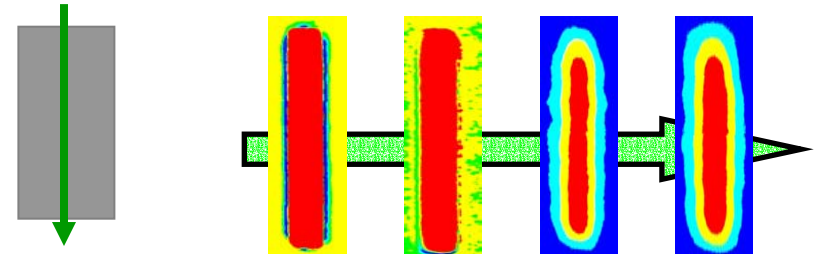
near line length(μm) far



No wafer rotation



near line length(μm) far

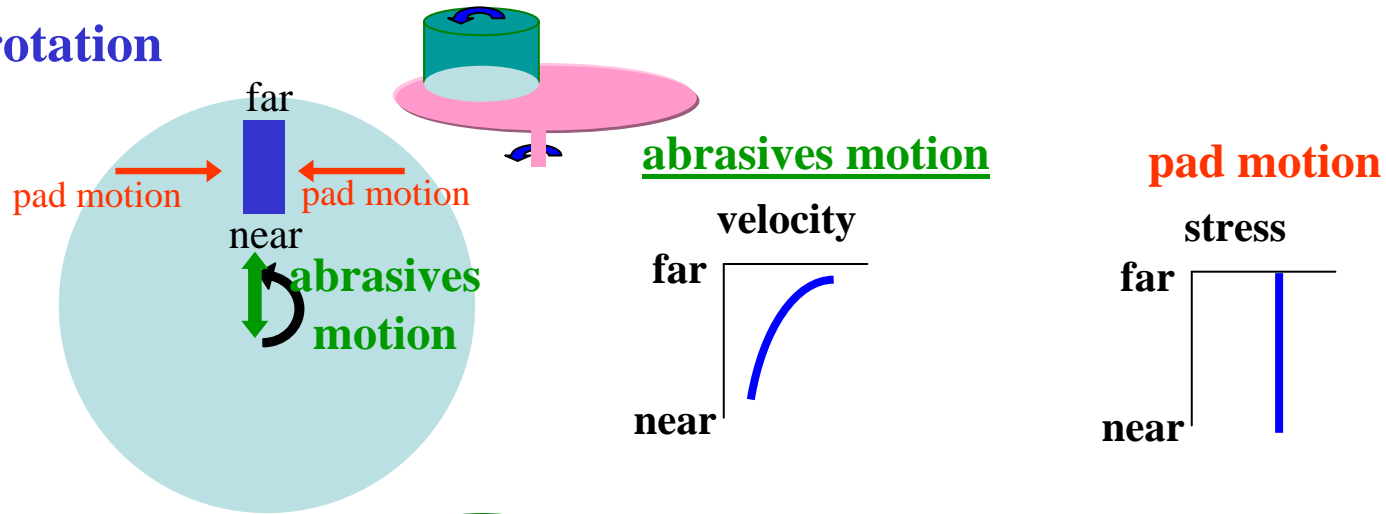


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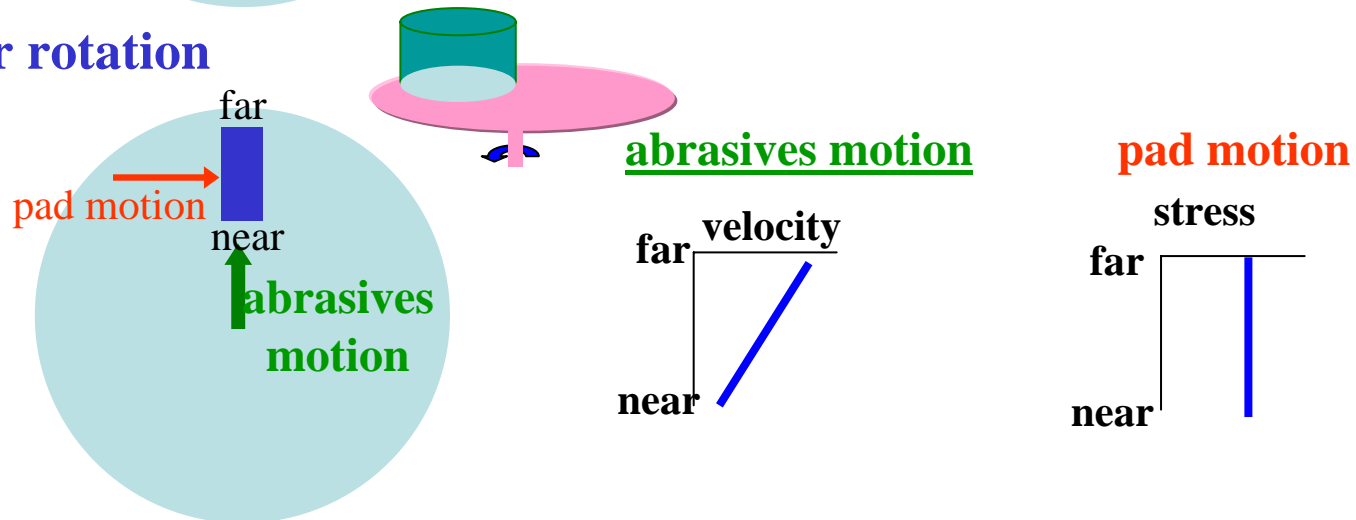


Analysis – Radial features

Wafer rotation



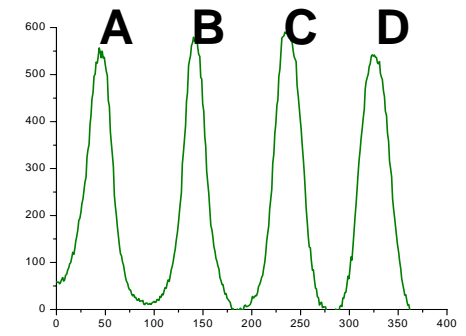
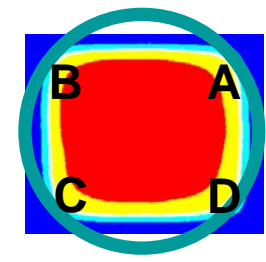
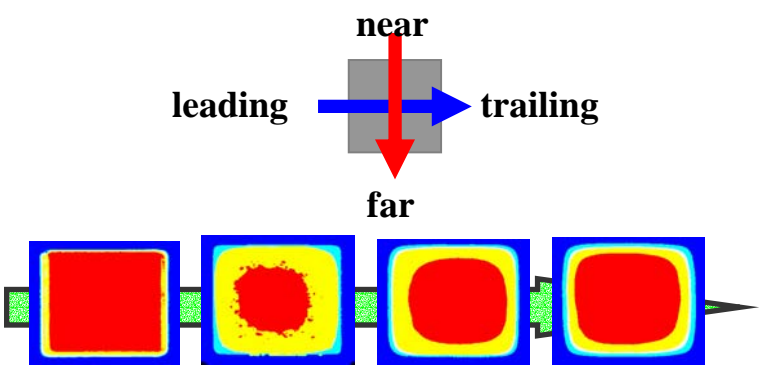
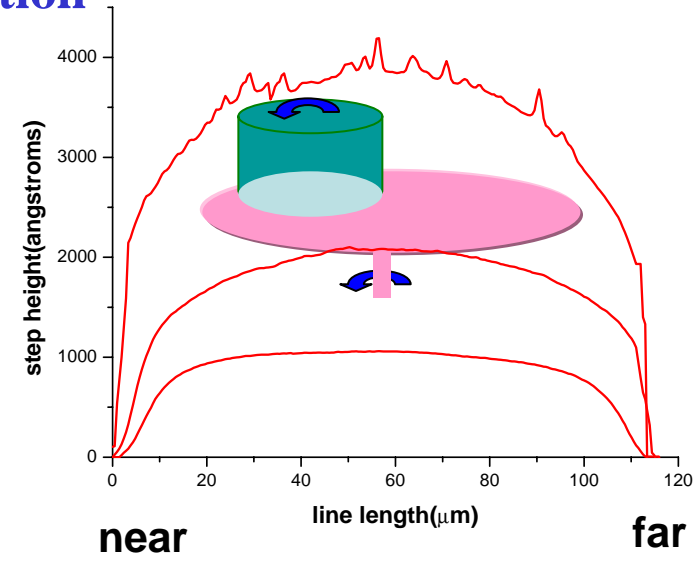
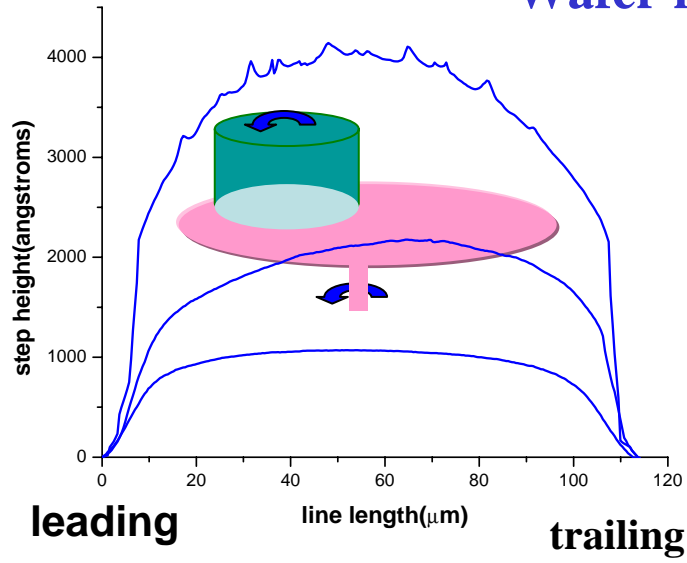
No wafer rotation



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Experimental Result – 2D features

Wafer rotation



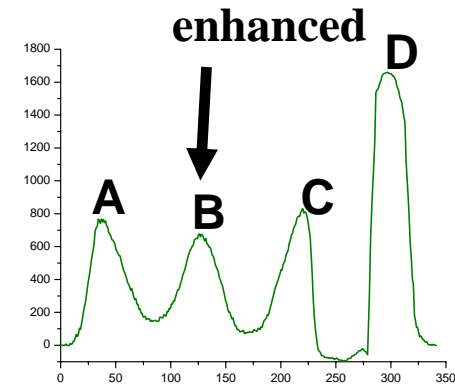
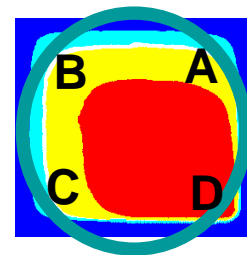
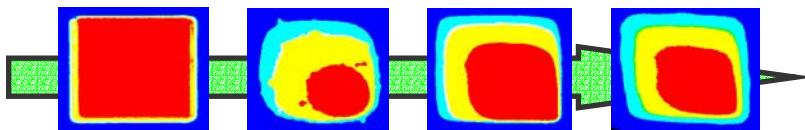
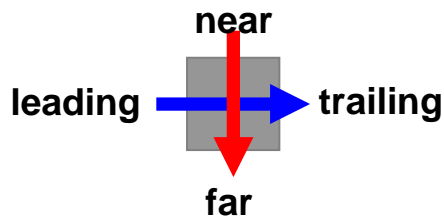
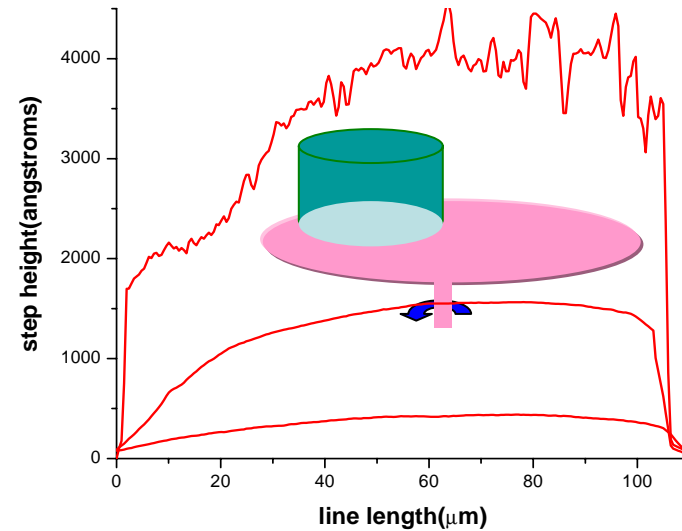
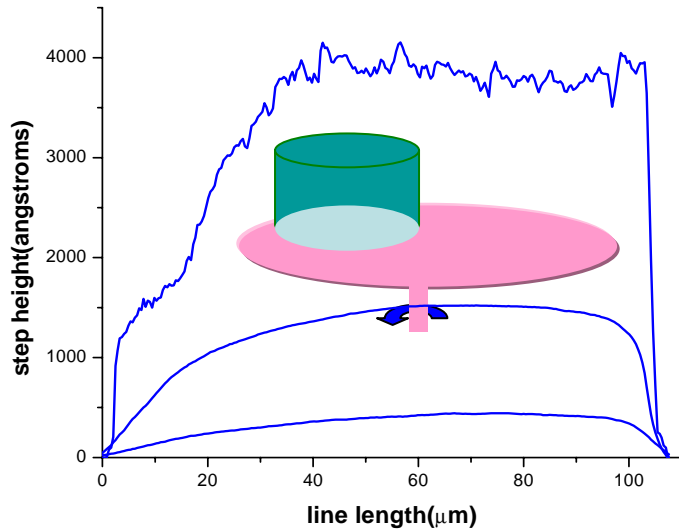
uniform removal

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Experimental Result – 2D features

No wafer rotation



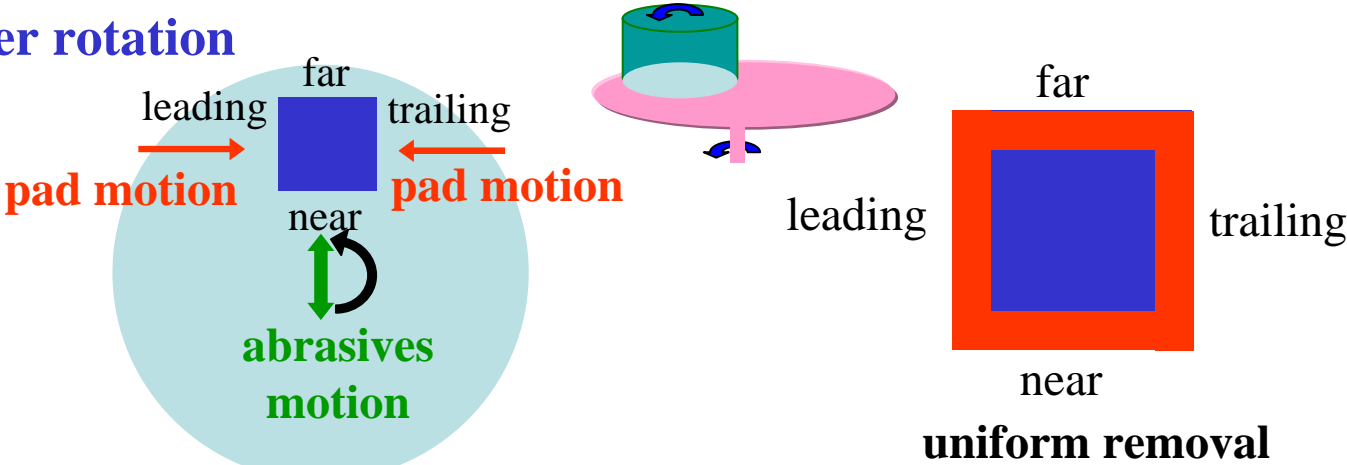
non-uniform removal

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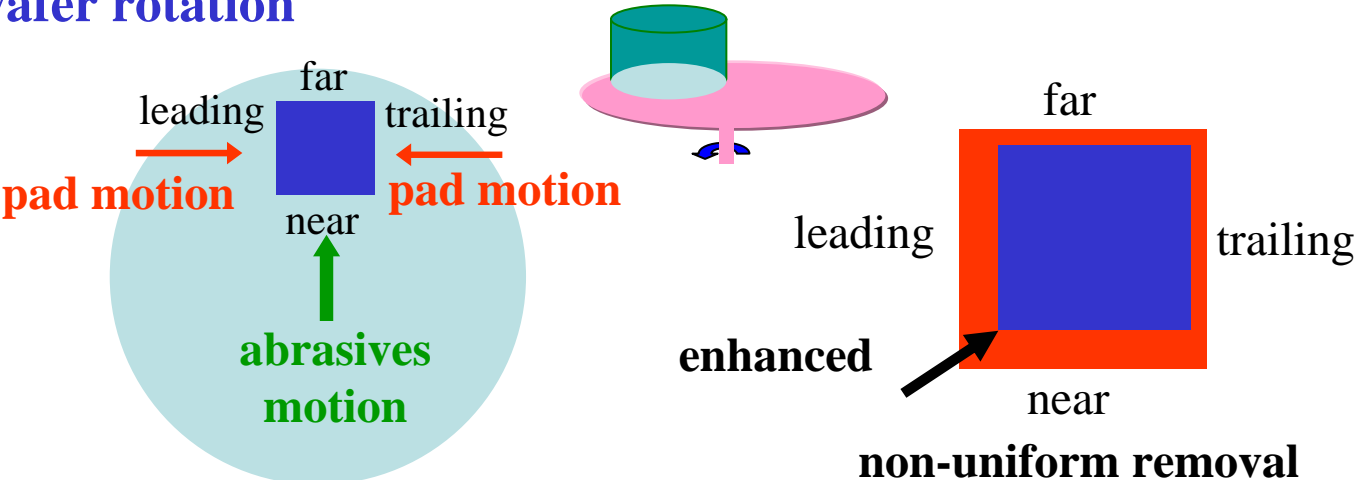


Analysis – 2D features

Wafer rotation



No wafer rotation



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Conclusions

- **Designed experiments based on orientation effects as a complementary to the pattern-density dependency model**
- **Showed different material removal patterns according to the orientation**
 - tangential: leading \gg trailing
 - radial: near \gg far
 - 2D: enhanced removal rate at the corner (leading edge and near edge)
- **Explained those patterns in terms of pad motion and abrasives motion**

Future Work

- Develop a model based on theoretical analysis
- Try different materials (nitride, poly-Si)
- Study dummy feature replacement and alignment marks in lithography

Acknowledgements

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