Modelling optical response of periodic nanosurfaces using FEM

Modelling of spectroscopic Mueller matrices of ordered nanoplasmonic surfaces using the finite element method

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Outline

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Problem formulation
Achievement goals

- Simulate optical properties of periodic plasmonic nanosurfaces

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  - Reflection from sample at oblique polar angle of incidence and full azimuthal angle rotation.

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    - Reflection from sample at oblique polar angle of incidence and full azimuthal angle rotation.
- Retrieve the sample Mueller matrix.
- Verify model by reproducing experimental results, mainly by comparing Mueller matrices.
- Apply model to other interesting structures.

Outline

Why metasurfaces?

- First item.

Why metasurfaces?

- First item.
- Second item.

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- First item.
- Second item.
- Third item.

Why metasurfaces?

- First item.
- Second item.
- Third item.
- Fourth item.

Why metasurfaces?

- First item.
- Second item.
- Third item.
- Fourth item.
- Fifth item.

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- Fifth item. Extra text in the fifth item.

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  - E.g. COMSOL Multiphysics, a commercial FEM software.

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Mueller-Stokes formalism

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Localized surface plasmon resonances

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Localized surface plasmon resonances

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- This effect is based on the interaction between light and the conduction electrons at a metallic interface or metallic nanoparticle
- A *localized surface plasmon resonance* (LSPR) is a non-propagating excitation of the electron plasma of metallic nanostructures coupled to an incident EM field
    - Time-varying E-fields associated with light waves exert a force on the electrons within a metallic nanoparticle and drive them into oscillation. At specific frequencies this oscillation is resonantly driven to produce a very strong charge displacement and associated field concentration, known as a LSPR.

Outline

Rayleigh anomalies

- Basic intuitive explanation of concept

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- Rayleigh-line equation

Outline

Finite element method (FEM)

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Finite element method (FEM)

- Basic intuitive explanation of concept
- pretty pictures

Outline

Gold particles on a substrate

Gold hemispheroidal particles on SiO_2 substrate

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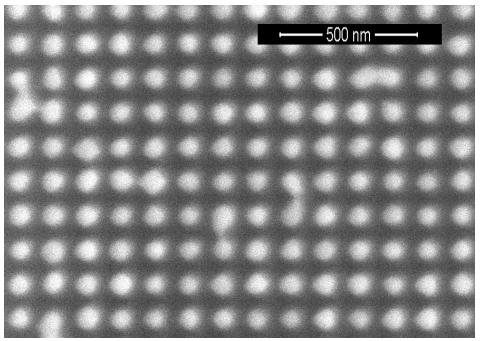
Gold hemispheroidal particles on SiO_2 substrate

- Sample 6



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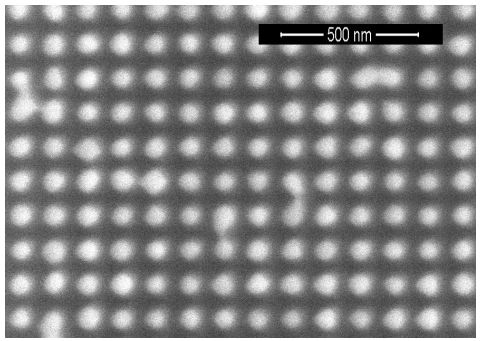
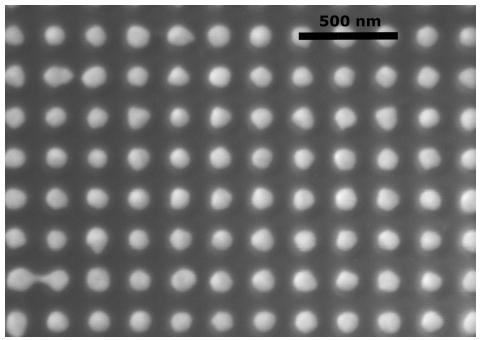


- Sample 5A



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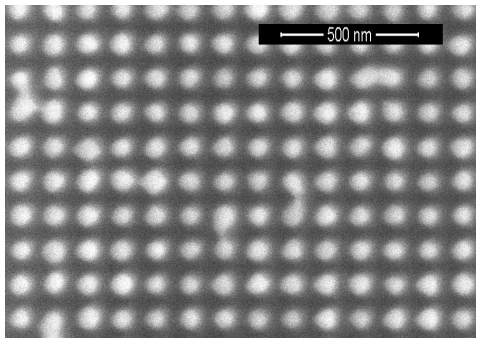
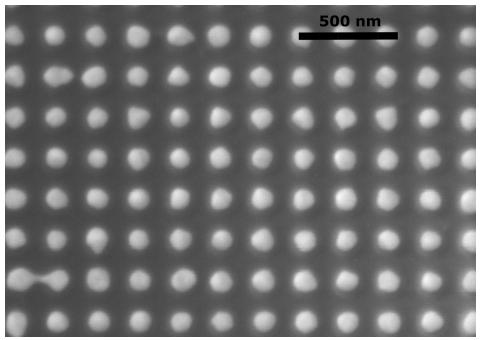


- Sample 5A

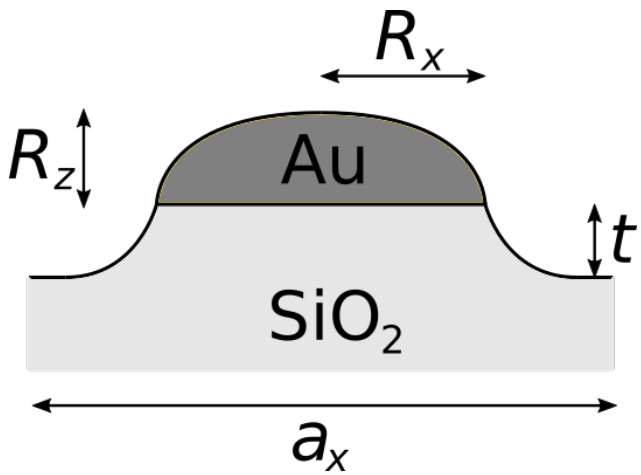


- Sample 5B

Sample geometries

Dielectric mound

- Each Au particle on all samples lie on top of a dielectric mound



- This is the result of an unintended effect of the milling process which caused an over-etching into the substrate of several nanometers

test

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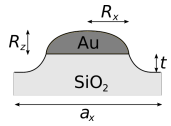

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Outline

Developing the COMSOL model

- 1

Unit cell geometries

- 1

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Summary

- The first main message of your talk in one or two lines.
- The second main message of your talk in one or two lines.
- Perhaps a third message, but not more than that.

- Outlook
  - Something you haven't solved.
  - Something else you haven't solved.

For Further Reading I


A. Author.
Handbook of Everything.
Some Press, 1990.


S. Someone.
On this and that.
Journal of This and That, 2(1):50–100, 2000.