Project Title: Modeling of nanoparticle plasmonic resonator for nanodevice applications

Creating new technologies has proven to be difficult as the size of components within devices reach a point where classical physics does not apply. Where the goal of the technologies being created is only being limited by the physical properties of materials being used. To overcome this issue different physical phenomena have been observed and are being applied in order to achieve devices with more computing power while also being small in size. An example being that metallic sphere's size being size being smaller than the light it is trying to capture. This process is called surface plasmon resonance, which takes advantage of free oscillating electrons in metallic surfaces by shining light on them. This oscillation produces signals in the form of reflected light that can be measured. Thus modeling and creating different designs that can increase the power of the reflected signal are sought after, using different materials with different physical properties that bend light or reflect light better are also being researched. In this project finding different combinations of materials and their designs were explored.

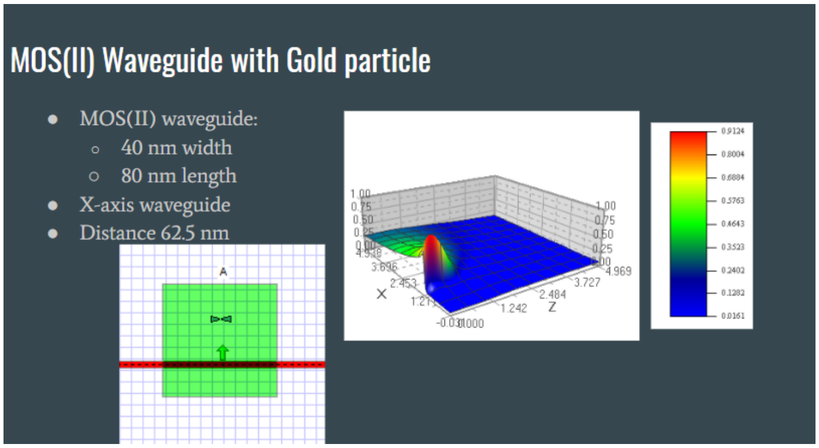
This project consisted of first reading, discussing and presenting assigned journals and scientific articles that spoke about the surface plasmon resonance. Then after getting enough knowledge on the topic, methodologies were devised that were inspired by the information that was presented. Next simulations were run using the methodologies that were created. The final step is to apply the simulation made to apply on real working devices.

Reading, Discussing and Presenting assigned journals and scientific articles:

In the first article that was assigned, the essential theory of Surface Plasmon Resonance (SPR) was the central point. It talked about the different properties that were attributed to it. According to the article Next-generation thermo-plasmonic technologies and plasmonic nanoparticles in optoelectronics, At the nanoscale theories of classical and quantum mechanics are not valid and various unexpected properties are possible because metal nanoparticles (Au, Ag, Cu) have an interesting property: They have a unique interaction with light due to the electron configuration of their S- orbitals being half filled, allowing them to oscillate freely in a parabolic shape. This causes the characteristic properties of thermal and electrical conductivity. The diffraction limit of light in dielectric media does not allow electromagnetic waves into the nanoscale regions smaller than the light wavelength. This limit is the most important part of the physical phenomena because it limits the advancement of technology. However using materials with negative dielectric permittivity allows it to go further than the diffraction limit. This was the driving motivation behind the project.

Simulations

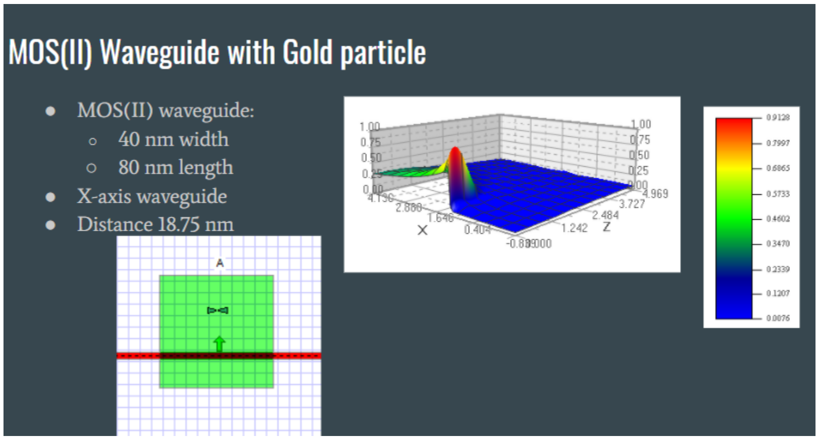
______Various simulations were run in order to study how SPR behaved and what results were produced. Three simulations using a sharp triangular design with MOS(II) as the material. This material was used due to its semiconductor nature. The simulations were constant while varying the distance between the particles



MOS(II) Waveguide with Gold particle

- MOS(II) waveguide:
  - 40 nm width
  - 80 nm length
- X-axis waveguide
- Distance 62.5 nm

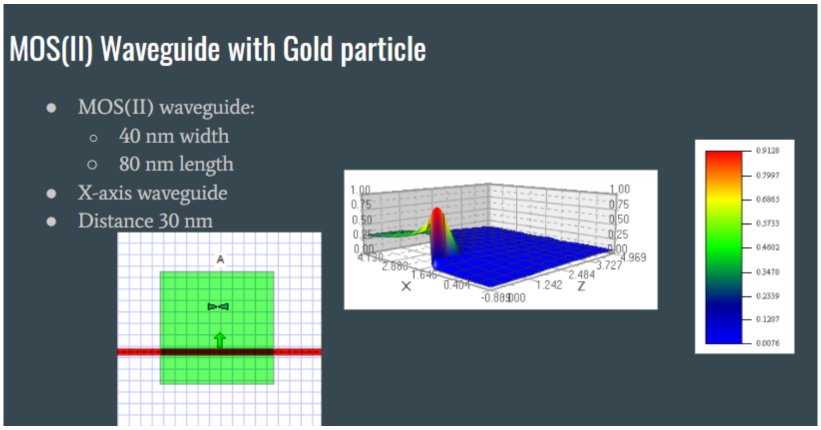
Figure 1



MOS(II) Waveguide with Gold particle

- MOS(II) waveguide:
  - 40 nm width
  - 80 nm length
- X-axis waveguide
- Distance 18.75 nm

Figure 2



MOS(II) Waveguide with Gold particle

- MOS(II) waveguide:
  - 40 nm width
  - 80 nm length
- X-axis waveguide
- Distance 30 nm

Figure 3

Conclusion

The various simulations that were run according to the knowledge and information learned in the articles and scientific journals allowed for a variety of data to be produced by the software Optiwave FDTD. However in the previous step this information was supposed to be used in real world devices but was not able to achieve this step. However in the future this allows for other researchers to learn from this mistake and go further than I was able to.