Directed Assembly of Functional Nanoparticles on a Field Generating Substrate

Co-Laboratory for **N**anoparticle Based **M**anufacturing & **M**etrology

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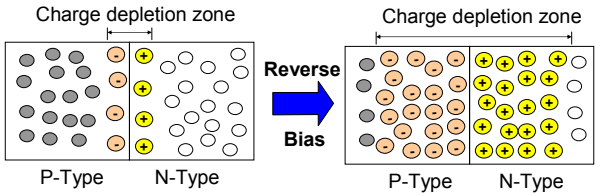
Funding: U.S. National Security Agency

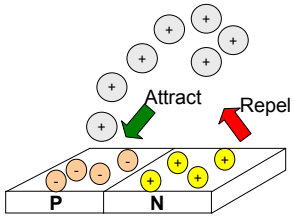
Idea: Electrostatic Force from Charge Depletion Zone of a P-N Junction

Formation of charge patterns:

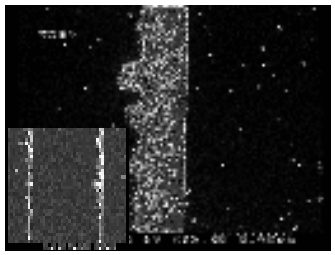


If we applied a reverse bias voltage, the depletion zone will be expanded

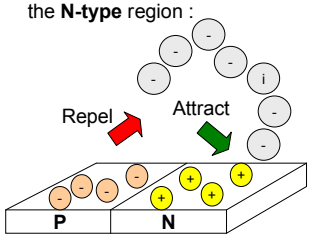
Align **positive** particles on the **P-type** region :



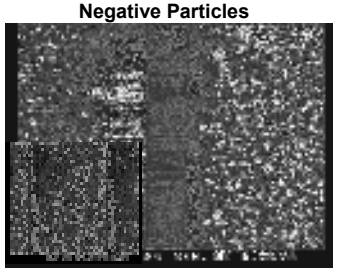
Positive Particles



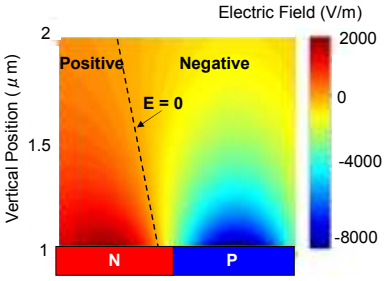
Position **negative** particles on the **N-type** region :



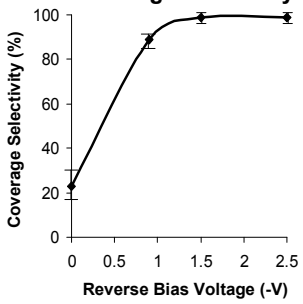
Negative Particles



Electric Field Distribution:

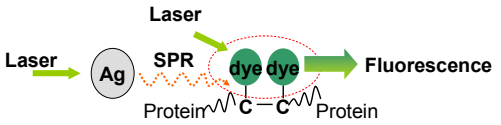


Coverage Selectivity



Application: Ag Nanoparticle-Based Bio-Sensor

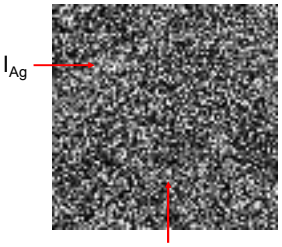
Background: **Surface plasmon resonance** (SPR) of Ag nanoparticles can enhance the fluorescence intensity in a bio-sensing process. Ag nanoparticle-based devices arouse great interest.



Two Steps
1. Prepare size-selected Ag nanoparticles
2. Create well-aligned Ag nanoparticles patterns on the substrates

1. Investigation of size dependent Fluorescence Characteristics

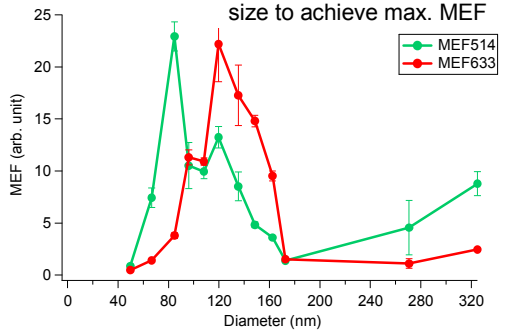
Strong fluorescence from Ag nanoparticles

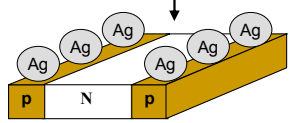


Metal Enhanced Fluorescence (MEF) :

$$MEF = \frac{I_{Ag} - I_{background}}{I_{substrate} - I_{background}}$$

We can tune the particle size to achieve max. MEF

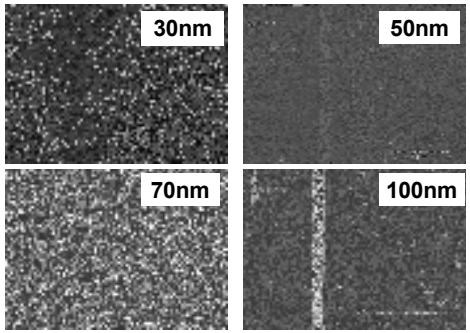




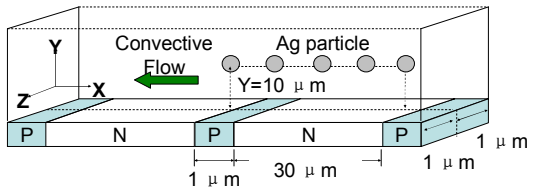
Ag Nanoparticle-Based Bio-Sensor

2. Assemble Ag nanoparticles on PN substrates

(1) Experiment : Size-selected Ag nanoparticles

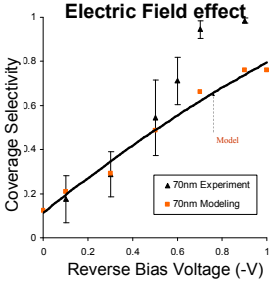


(2) Simulation by our PN model: to investigate the effect of **particle size**, **electric field** , **convective flow**, **pressure** et al.

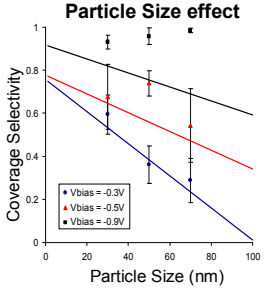


Compare the simulation result with the experiments:

Electric Field effect



Particle Size effect



PN model can predict the trend of **coverage selectivity v.s each parameter** (particle size, voltage, et al), and it can also predict a **minimum coverage selectivity** achieved in the process.