Lewis University
STEM Undergraduate Research Experience (S.U.R.E.) 2019
Faculty Mentor – Project Application

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Department: Physics

Research Project Title: Self Assembly of Nanophotonic Systems

We propose to enhance the sensitivity of photodiodes and LED based optical chemical sensors using resonant plasmonic nanostructures deposited on front junction panels. We have shown recently that the assembly of metal nanoparticles (NP) into resonant grating patterns tuned for the eigenfrequency of close-packed NP arrays can enhance the incoming light intensity by ~10^5 in the gap regions between nanoparticles. By depositing organic luminescent dye molecules or quantum dots over the structured NP arrays, and adjusting both the grating frequencies and luminescent media emission to the maximum sensitivity of the semiconducting photodiodes, we may be able to improve both their intensity and spectral response and produce an inexpensive, efficient platform for fluorescent and SERS bio-chemical sensing.

In this work, we focus on capillary self-assembly, in which the dispersion of Au NPs will be spread and dried onto a chosen substrate. As drying occurs, surface tension plays a significant role in moving the Au NPs across the surface. Surface tension forces are dominant in the nano and micro-scale regime provided there is a liquid interface. In the dry regions, electrostatic forces would be dominant. The surface tension force of the liquid-substrate interface is the force that holds a Au NP to the site and controls the alignment of the assembly. This surface tension determines the contact angle of the dispersion fluid and hence by altering the contact angle we can affect the self-assembly and design it to match the properties of the Au NP dispersions and the desired substrate.