Master Thesis Project
Synthesizing complex colloids for enhanced photonic sensing

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Light-utilising technologies play an important role in our everyday lives, and will likely become even more important in the near future with novel applications such as optical circuitry and sustainable photocatalysis. To enable such optical (nano)technologies, it will be essential to collect and deliver optical energies as efficiently as possible.

In the lab, light in/outcoupling is usually achieved using microscope objectives. However, placing a simple glass sphere near a point light source can already help reangle the emitted light, which facilitates light outcoupling (Figure 1). Dr Kamp uses colloidal particles as “nanolenses” to enhance the efficiencies of optical systems. She currently concentrates on coupled plasmonic nanoantennas [1], which are a powerful tool to study atomic, molecular and nanophotonic processes [2]. Normally, these plasmonic antennas emit at roughly 60° angles with respect to the surface normal. Using various sizes of organosilica nanolenses, these emissions can be tilted to near-normal incidence.

We are interested in finding out how the emission angles change when the underlying plasmonic construct is altered. In particular, we wish to find out if directional emission by the nanolens is retained when the orientation of the plasmonic construct is rotated with respect to the lens (Figure 2).

In this Master’s project, we will try to incorporate a plasmonic dimer into an organosilica nanolens. First, we will investigate ways to reproducibly prepare gold nanoparticle dimers and characterise the assemblies. Then, colloidal synthesis methods will be employed to incorporate the dimers into a nanolens, where our task is to ensure that the dimers remain intact. Electron microscopy techniques will be used to accurately characterise the morphology of the hybrid structures thus created. Optical analysis techniques will be used to document some of their key optical properties such as their absorption resonance. Finally, and time allowing, we will investigate whether we can deduce information on emission angles from these constructs.