Technical Note C01: *Overview of Gold Nanorods*

Nanoparticles range in size from 1-100 nm. At this scale, materials behave quite differently than in bulk and have an extremely high surface area compared to the amount of material per particle. This unique state leads to distinctive physiochemical and optical properties due to electron confinement and high surface areas. When the nanorods are illuminated with a light source, the electric field causes the oscillation of the conductive-band electrons at the surface of the particle [1]. The visual color interpretation of the rods in solution are cumulatively attributed to both absorption and scattering. The free electrons oscillate along both the long and short axis of the nanorod [2]. The stronger resonance band is attributed to the length of the nanorod with absorption peak maxima ranging from 550nm to the near-infrared (NIR). The shorter and weaker resonance band is attributed to the diameter of the nanorods with absorption peak maxima ranging from 505nn to 530nm.

Our processes for manufacturing uses 1D surfactant-directed synthesis with proprietary protocols that lead to highly, unmatched mono-dispersed and well characterized nanorods. The resultant bare nanorods are capped with a bilayer in which one polar head faces the gold and the other polar head faces the aqueous solvent. The non-polar hydrocarbon tails point inward resultant of van der Walls forces and face away from the polar solvent (Figure 1).

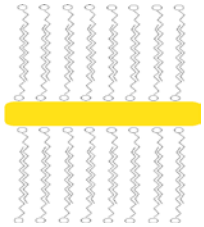
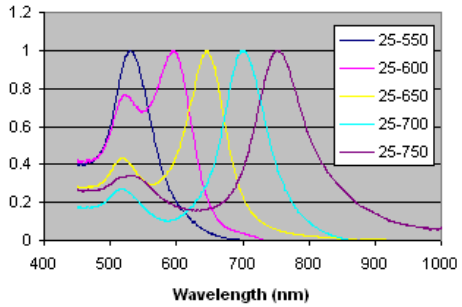
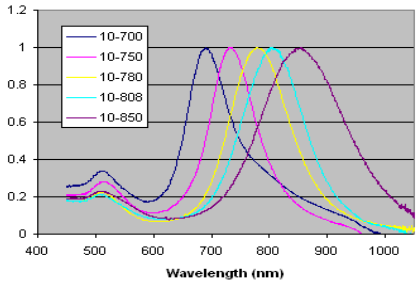


Figure 1 CTAB Bilayer Surrounding a Gold Nanorod

We are able to tune the longitudinal absorption plasmon of the nanorod from the lower range of the visible spectrum at 550nm up into the near-IR at 950nm (Figure 2) by varying the aspect ratio of the rods, i.e., length/diameter ratio. The construct is divided into two major product lines: UV/Vis and NIR. In the UV/Vis line, the diameter of the nanorod is ~25nm with lengths ranging 34nm – 86nm, and the longitudinal absorption plasmon ranges 550nm – 750nm. This spectral response profile is well suited to imaging, diagnostics and *in vitro* research. The NIR line consists of rods with diameters of ~10nm, lengths ranging from 29nm – 55nm, and a longitudinal absorption profile that ranges 700nm – 950nm. These particles are well suited for imaging, therapies and *in vivo* research. For life science projects, the particles are 'biosafe' and have been shown to be non-cytotoxic for *in vitro* research in human cells [3].





If you require constructs farther into the near-IR, please see our information on our high-aspect-ratio (HARs) particles.

The surface of the gold nanorods allow for multifunctionalization. Using simple ligand exchange procedures or gold-thiol chemistries, we are able to 'coat' the nanorods with a variety of moieties such as biocompatible polymers or tethered with drugs, biomarkers, proteins, antibodies, enzymes, RNA, DNA, oligos, carboxyl-, amine-, methyl-, biotin- and NeutrAvidin-terminated proprietary polymers, a multitude of chemical functionalizations and infinitum. We can also provide custom conjugations to the nanorods with your specialized research materials. Please contact us for further information and a quotation.

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1. Link S, El-Sayed MA: Spectral properties and relaxation dynamics of surface-plasmon electronic oscillations in gold and silver nanodots and nanorods. *J. Phys. Chem. B* 103(40), 8410-8426 (1999).
2. El-Sayed MS: Some interesting properties of metals confined in time and nanometer space of different shapes. *Acc. Chem. Res.* 34(4), 2457-264 (2001).
3. Connor EE, Mwamuka J, Gole A, Murphy CJ, Wyatt MD: Gold nanoparticles are taken up by human cells but do not caase acute cytotoxicity. *Small* 1(3), 325-327 (2005)