Colloidal Plasmonic Nanostructures

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The assembly of nanoparticle building blocks is a pre-requisite for the amplification of the properties of the components and/or the generation of new features unique to the ensemble [1]. Usually, nanoparticles employed for these assemblies are spherical and lack a geometrical preference toward directional self-assembly, thus limiting their potential applications. In contrast, controlled self-assembly of non-spherical nanoparticles, such as gold nanorods, enables these arrays to form defined 1D, 2D or 3D structures with a vectorial dependence of the desired properties. I will present in this lecture several examples of directional assembly of gold nanoparticles, resulting in unusual optical properties, which are a consequence of the particular configuration within the assembly [2, 3].

Standing 2D and 3D superlattices made of gold nanorods can be obtained through the use of gemini surfactants as capping agents in aqueous solution. The extreme directionality of these assemblies is reflected in the anisotropic optical properties of the crystalline superlattices, which additionally display extraordinary antenna effects, rendering them excellent SERS substrates [4].

A completely different type of self-assembly in solution has been recently found for PVP-coated gold nanorods, when dispersed in N-methylpyridine and irradiated with UV light. In this case, the assembly invariably results in ladder-like structures that display novel plasmon resonance modes that were typically restricted to gold nanostructures on solid substrates [5].

Alternatively, the assembly can be directed by using different types of templates. For example, when gold nanorods are adsorbed on chiral fibers, special arrangements are obtained that display extremely high optically activity, even in solution.

These and other recent examples of directed nanoparticle assembly will pave the way toward the design of novel devices based on the remarkable plasmonic properties characteristic of the assemblies.

References

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