

From hairy particles to particle-based metamaterials

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Metallic nanoparticles offer a number of interesting optical and electronic effects. A prominent example is the localized surface plasmon resonance (LSPR), which is due to resonance excitations of the particle's free electron cloud vibrations by light. Consequently plasmonic nanoparticles provide excellent opportunities for controlling electromagnetic near-fields at optical frequencies, which has led to a wide range of applications in various fields such as surface-enhanced spectroscopy, light harvesting, or photonics.

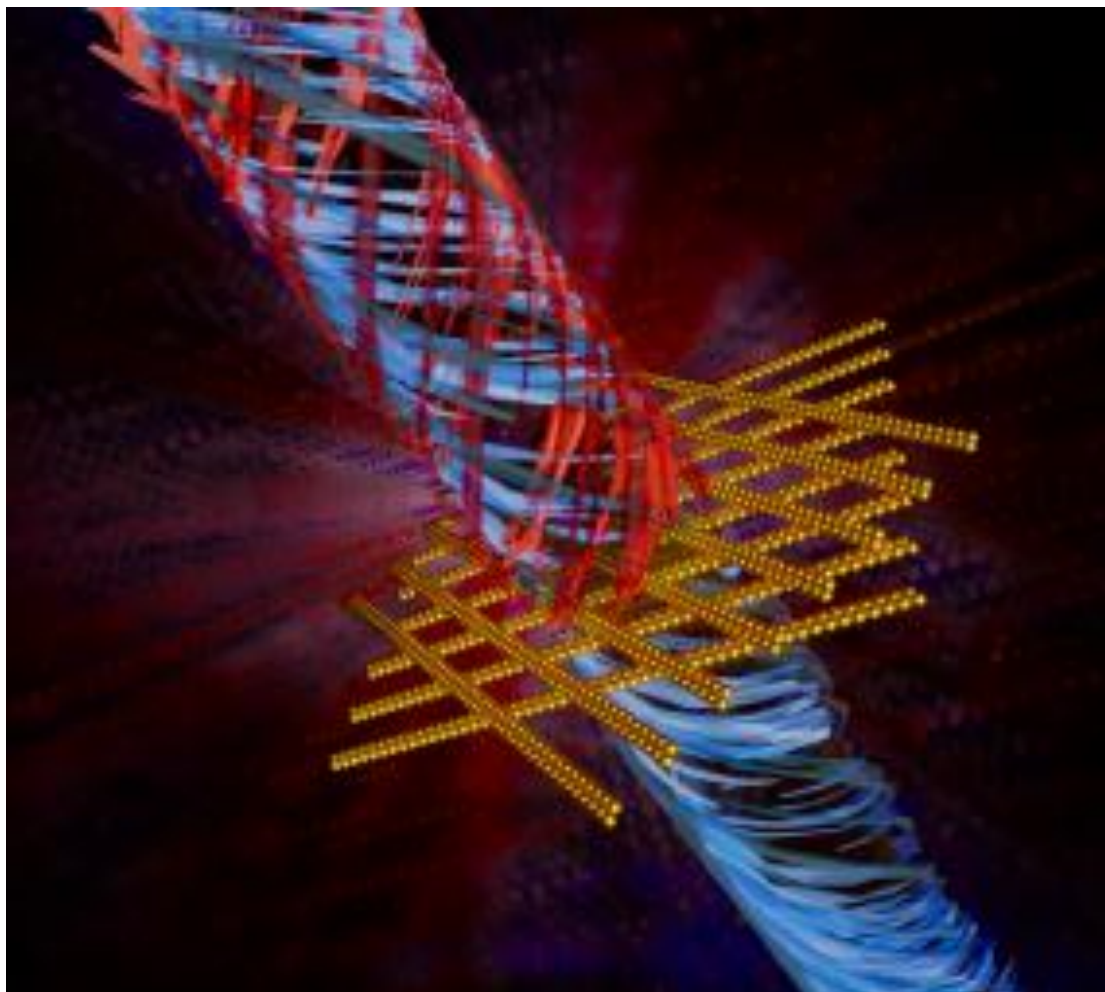
While much of the research has been devoted to understanding nanoparticle synthesis and tailoring their LSPR at the single-particle level, novel perspectives arise from combining plasmonic nanoparticles with a functional polymeric shell which does not only allow controlling inter-particle distances but as well tailor transport / electronic coupling. [1,2,3]

Increasing the level of complexity, the ordering of particles at different length scales opens another powerful routes to optical and electronic functionality due to novel collective plasmonic excitations arising from plasmonic coupling effects. We focus on achieving such ordered particle arrays through self-assembly approaches. Colloidal self-assembly can indeed yield well-defined colloidal clusters and surface arrays [4] in which coupling effects can be controlled. In particular, large-scale assemblies are possible in combination with biomimetic surface patterning like controlled wrinkling. We discuss the underlying physicochemical principles of the structure formation process and the resulting plasmonic coupling effects including chiroplasmonic metamaterial effects [5, 6]. Finally, we present perspectives on how these assembly principles can be relevant for developing circular economy approaches for advanced materials.

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Figure:



Schematic of a giant circular dichroitic metamaterial, adopted from [5]