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Hybrid nanoparticles self-assembled superstructures – Prof. Valerie Marchi

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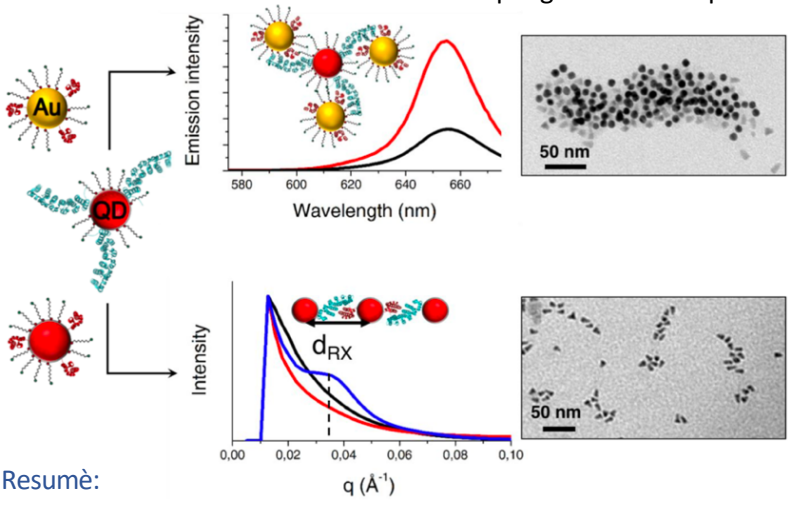
Abstract : Self-assembled superstructures composed of metallic and semi-conductor nanoparticles are key objects in nanoscience since they combine the chemical, optical, electronical properties of both types of nanoparticles and offer mesoscale functional interfaces with tailored optical collective properties.[1,2] The interdistance in the hybrid emitter-plasmon colloidal assemblies is crucial to control the near-field coupling and optimize the optical response.[3,4] In this respect, they have gathered an increasing interest from research groups worldwide in the last couples of years. The coupling of such nanoparticles with biomolecules is highly desirable and relevant for many aspects such as (i) high affinity and specificity of their molecular recognition properties to drive self-assembly, (ii), the rigidity of their well-defined 3D structure (iii) the incorporation of biological functionality thus opening opportunities for biological applications including biosensors and bioimaging.[5,4]

Here optically active hybrid nanostructures are constructed by coupling fluorescent quantum dots and plasmonic gold nanoparticles. The self-assembly is directed by the strong affinity between two artificial α-Repeat proteins that are introduced in the capping layers of the nanoparticles at a controlled surface density. The proteins have been engineered to exhibit a high mutual affinity, corresponding to a dissociation constant in the nanomolar range. The molecular recognition properties are conferred to the protein-functionalized quantum dots and gold nanoparticles as demonstrated by gel electrophoresis and Surface Plasmon Resonance technique. The structure of the large colloidal superstructures of complementary nanoparticles has been analyzed by transmission electron microscopy and X-ray scattering. The self-assembling process leads to a very well defined sub-10 nm interparticle distance that strongly affects the emission properties of the quantum dots in hybrid ensembles. Our results open the route to the design of hybrid emitter-plasmon colloidal assemblies with controlled near-field coupling and better optical response.



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Resumè:

Valerie Marchi graduated in Condensed Matter, Chemistry and Organization at University Pierre Marie Curie (Paris) in 1994. Since then she consolidated her experience in the field of Molecular recognition between complementary lipidic membranes achieving a full position as Research scientist (C.N.R.S.), Collège de France, Paris in 1998. From 2003 She is an international expert for the European Research Council (ERC) and for the IFCPRA (Indo-french centre for the promotion of advanced research) national Expert for the ANR, the C'Nano Ile de France, PhD and HDR defenses jury member (3/year).Since 2009, she is the Research director (C.N.R.S.) (section 12) at the institut de Sciences chimiques de Rennes, Université Rennes 1, UMR 6226 CNRS where she is currently working.