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Covalently Conjugated Gold–Porphyrin Nanostructures

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Abstract : Hybrid molecular–nanoparticle materials, obtained with a bottom-up approach, are suitable for the fabrication of functional nanostructures showing structural control and well-defined properties, i.e., optical, electronic or catalytic properties, in the perspective of applications in different fields of nanotechnology. Gold nanoparticles (Au NPs) exhibit important chemical, electronic and optical properties due to their size, shape and electronic structures. In fact, Au NPs containing no more than 30-40 atoms are only luminescent because they can be considered as large molecules with discrete energy levels, while nano-sized Au NPs only show the surface plasmon resonance. Hence, it appears that gold nanoparticles can alternatively be luminescent or plasmonic, and this represents a severe constraint for their use as an optical material. The aim of this work was the fabrication of nanoscale assembly of Au NPs covalently anchored to each other by means of novel bi-functional porphyrin molecules that work as bridges between different gold nanoparticles. This functional architecture shows a strong surface plasmon due to the Au nanoparticles and a strong luminescence signal coming from porphyrin molecules, thus, behaving like an artificial organized plasmonic and fluorescent network. The self-assembly geometry of this porphyrin on the Au NPs was studied by investigation of the conformational properties of the porphyrin derivative at the DFT level. The morphology, electronic structure and optical properties of the conjugated Au NPs – porphyrin system were investigated by TEM, XPS, UV–vis and Luminescence. The present nanostructures can be used for plasmon-enhanced fluorescence, photocatalysis, nonlinear optics, etc., under atmospheric conditions since our system is not reactive to air nor water and does not need to be stored in a vacuum or inert gas.

Keywords : gold nanoparticle, porphyrin, surface plasmon resonance, luminescence, nanostructures
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