Plant virus capsids: 3D scaffolds to organize nanoparticles

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The ability to construct three dimensional architectures via nanoscale engineering is important for emerging applications of nanotechnology in sensors, catalysis, controlled drug delivery, microelectronics, and medical diagnostics. Because of their well-defined and highly organized symmetric structures, high robustness over wide ranges of temperature, pH, buffer, and in the presence of organic solvents, viral capsid proteins then provide a 3D scaffold for the precise placement of plasmon or magnetic materials yielding hierarchical hybrid materials. In this study, we use several plant viruses with different shapes and morphologies: Turnip yellow mosaic virus (TYMV), Rice yellow mottle virus (RYMV), Tobacco mosaic virus (TMV) and Potato virus X (PVX). Two ways are possible to obtain nanostructure onto capsid: grafting pre-formed nanoparticles or biomineralization.

In the first part of this work, I will present the synthesis and characterization of new nano-bio-hybrid materials, which are soluble and stable in solution. Gold nanoparticles (AuNP) of different sizes (5, 10 and 20 nm) were grafted on icosahedral capsid, according to two strategies. After purification, the resulting nano-bio-hybrids were characterized by different technics (DLS, TEM, XPS...). Similarly, we grafted onto the virus capsid iron oxide nanoparticles (IONP) synthetized by the polyol process, and then characterized the objects, specifically their magnetic properties.

In the second part, gold biomineralization experiments on TMV and PVX will be described. The size, morphology, monodispersity of AuNP and gold assembly on virus were studied according to the experimental conditions (concentrations of reactant, number of cycle, nature of reductant…) and in situ TEM observations directly in liquid media were also performed to unravel the nucleation and growth mechanisms.