Studies of nanoparticle-virus complexes

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Abstract: We have enclosed an optically active nanoparticle inside a virus coat to create a virus-like, intracellular optical probe. The core-shell interactions of the self-assembled, nanoparticle-enclosing capsids are investigated spectroscopically and compared with intact viruses.

We have recently shown that the same principles that govern the virus particle assembly from capsid subunits and nucleic acid aggregates can be put at work to incorporate gold nanoparticles in the cavity of an icosahedral virus [1]. Single viruses containing such metal nanoparticles are optically detectable, Fig. 1. Non-intrusive, in-vitro spectroscopic studies of viral dynamics become thus, possible.

The main question is whether the nanoparticle incorporation influences the structural dynamics of the assembled virus capsid and/or the self-assembly pathways. We probe the time-resolved dynamics of tryptophan side chains within the capsid to compare nanoparticle-containing capsids, empty capsids, and nucleic acid containing capsids (viable viruses). Different functional groups, protecting the particle surface, are tested in order to minimize the differences between modified and intact virus particles. We demonstrate here that such experiments can be done in a physiological environment on single capsids, therefore alleviating the uncertainty arising from heterogeneous subpopulations of viral particles.

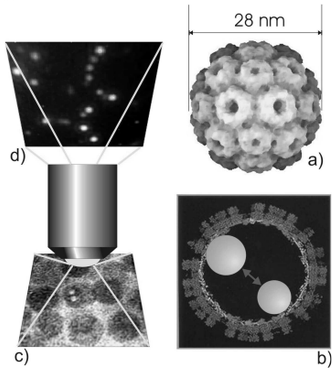

Fig. 1. Collage showing pairs of Au particles incorporated during the self-assembly in virus capsids from protein subunits, and their optical signatures. (a) Reconstructed BMV capsid [2]. (b) Schematic of two Au nanoparticles enclosed in a capsid. The distance between the particles is an important parameter for the optical spectral signature of the complex. (c) TEM picture of a pair of Au nanoparticles encapsulated in a capsid surrounded by reassembled capsids with RNA inside. (d) Dark-field scanning confocal microscopy of individual virus capsids containing gold nanoparticles in aqueous buffer.

Using similar techniques, conformational changes of protein-RNA complexes upon RNA binding could be followed in real-time, in the future. The real-time tracking of virus-like intracellular probes to map the intracellular and intercellular viral pathways may also become possible.

References:

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[2] Reddy, V., Natarajan, P., Okerberg, B., Li, K., Damodaran, K., Morton, R., III, C. B., Johnson, J."VIrus Particle ExploreR (VIPER), a Website for Virus Capsid Structures and Their Computational Analyses", *Journal of Virology* **2001**, *75*, 11943-11947.