

# Preparation and Comparison of Dense Polymeric Shells on Inorganic Nanoparticles

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Precise control of particle stability and nanobiointerface is crucial for most bioapplications. Nanoparticle characteristic properties are completely altered after adsorption of protein corona in biological environment. Many applications become complicated due to the non-specific binding of proteins to surface or interactions of nanoparticles with cells. To avoid these inconveniences, inorganic nanoparticles need to be coated by electroneutral polymers with antifouling properties which create intact surface and stabilize nanoparticles by steric hindrance. Various hydrophilic polymers were used for this purpose such as poly(ethylene oxide), poly(2-alkyl-2-oxazolines), poly(amino acids), polysaccharides, polyglycerol or poly[N-(2-hydroxypropyl)methacrylamide] [1].

We describe the methodology how to coat inorganic nanoparticles with dense polymeric shell composed of various types of polymers - poly[N-(2-hydroxypropyl)methacrylamide], poly(2-alkyl-2-oxazolines) and polyglycerol. Polymeric shells are created by „grafting from” method. All polymer-coated nanoparticles possess highly suppressed ability to non-specifically bind on biostructures (proteins or cells) and enable biomolecules’ conjugation, supporting their specific interaction with target [2,3].

We describe various procedures how to compare these exceptional polymeric shells, which are not distinguishable by simple methods such as particle colloidal stability and interaction of nanoparticles with proteins measured by Bradford assay. Two procedures evaluate interaction of nanoparticles with proteins: (i) surface plasmon resonance with various proteins displayed on gold chip and nanoparticles in a solution and (ii) fluorescence correlation spectroscopy with both proteins and nanoparticles in a solution. Third method compares non-specific interaction and adhesiveness of various polymer-coated nanoparticles with cells using flow cytometry.

As inorganic nanoparticles, we use fluorescent nanodiamonds (FNDs), which are a perspective material for the preparation of near-infrared fluorescent probes for bioimaging due to their unique and attractive properties such as unlimitedly stable fluorescence, sensitivity to magnetic and electric fields and broad biocompatibility. Contrary to other compounds, nanodiamonds do not photobleach or photoblink and have long fluorescence lifetime [4].

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- [1] Z. Amoozgar and Y. Yeo, *Wiley Interdiscip. Rev. Nanomed. Nanobiotechnol.*, 2012, **4**, 219.
- [2] J. Slegelova, M. Hajek, I. Rehor, F. Sedlak, J. Stursa, M. Hruby and P. Cigler, *Nanoscale*, 2015, **7**, 415.
- [3] L. Zhao, Y.-H. Xu, H. Qin, S. Abe, T. Akasaka, T. Chano, F. Watari, T. Kimura, N. Komatsu and X. Chen, *Adv. Funct. Mater.*, 2014, **24**, 5348.
- [4] V. Vijayanthimala, D. K. Lee, S. V. Kim, A. Yen, N. Tsai, D. Ho, H.-C. Chang and O. Shenderova, *Expert Opin. Drug Deliv.*, 2015, **12**, 735.