Spatial Distribution and Optical Response of Gold Nanoparticles within thermosensitive Polymer Brushes

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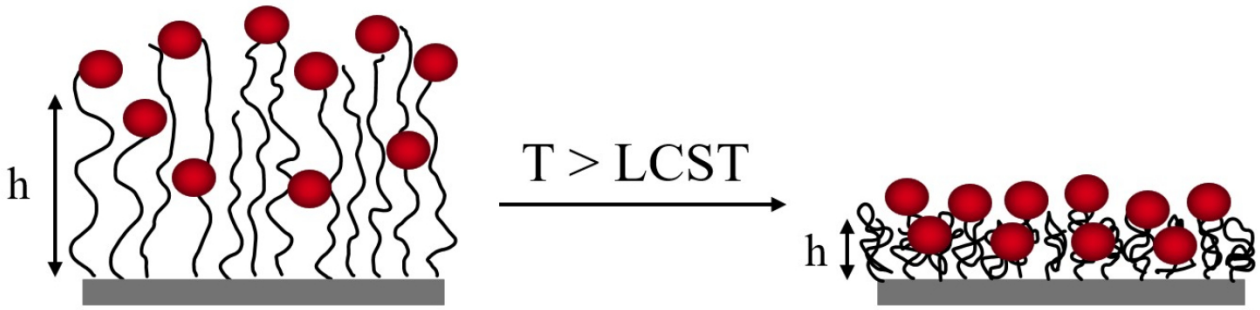
Metal/polymer nanocomposites are versatile hybrid materials and find use in many fields such as photonics, biomedical engineering and catalysis. A promising realization of this type of hybrid material is the controlled self-assembly of gold nanoparticles (AuNPs) inside a polymer brush, which induces color changes upon exposure to environmental changes ultimately enabling sensor applications.
Polymer brushes serve as a matrix for the immobilization of AuNPs. Particle uptake into the brush matrix is affected by several parameters such as brush thickness, particle size and the grafting density [1,2]. Uptake of nanoparticles has proven to be highest at intermediate grafting densities [3]. In the present study thermoresponsive Poly(*N*-Isopropylacrylamide) (PNIPAM) brushes with varying grafting densities are synthesized directly from a silicon substrate by a controlled radical polymerization (SI-ARGET ATRP). Nanocomposite materials are fabricated by dip-coating polymer brushes into a AuNP suspension. The topography of the nanocomposite coatings is characterized by atomic force microscopy, the vertical particle distribution is investigated by neutron and X-ray reflectometry, and optical properties are characterized by in situ spectroscopic ellipsometry.
This study reveals the grafting density-dependent penetration of particles into the brush, where particle uptake is found to scale with the inverse of grafting density. The relation between particle distribution and temperature-induced structural changes will be presented. As an outlook, the usage of AuNPs within polymer brushes as hotspots for local photothermal heating will also be discussed.

Keywords:
Polymer Brush, PNIPAM, Gold Nanoparticles, Neutron Reflectometry, Spectroscopic Ellipsometry



Sketch of Gold Nanoparticles within a swollen PNIPAM brush (left) and a collapsed PNIPAM brush (right). Changing polymer brush solvation by external stimuli allows to tune the particle proximity, which modulates the optical properties.

References:

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Acknowledgements:

This work was supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) through GRK2516 (Grant No. 405552959).