"Watching" Single Peptide – Single Nanoparticle Interactions using High-Speed Atomic Force Microscopy

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Single protein kinetics are of broad interest in nanobiointeractions, including nanoparticle corona and protein adsorption to material surfaces[1]. Ascertaining the kinetic information, e.g. protein binding, fluctuation or diffusion, while observing protein structure/conformation is ideal. Though conventional approaches for studying dynamics of molecular interactions with surfaces and materials is challenging. For example, the often rough, opaque and fluorescent quenching properties of real-word materials are not amenable to optical and fluorescence techniques for tracking single molecule dynamics. This is where emerging nanoscale and molecular characterization techniques, such as High-Speed Atomic Force Microscopy[2], present exciting opportunities for revealing the molecular dynamics on material surfaces.

High-Speed Atomic Force Microscopy (HS-AFM) surpasses the capabilities of conventional AFM by enabling acquisition times of 50-100 milliseconds per image. This takes HS-AFM into the realm of video rate imaging that is defined as achieving speeds of »12 frames/sec; the human eye needs to visualize a sequence of images at this speed in order to perceive motion. Coupled with the ability to achieve 1-2 nanometer lateral image resolution in liquid, the HS-AFM has the unique ability to provide significant insight into both the nanoscale structural and interaction dynamics of single molecules and molecular assembly processes on surfaces in real-time[2].

In this presentation, we will highlight the use of HS-AFM for directly visualizing the structural-dynamics of single peptide – single nanoparticle interactions (Figure 1). Aβ peptide interactions with silica and gold nanoparticles are visualized, with the aim of understanding kinetic pathways leading to different complexes under physiological conditions. We also wish to explore the use of functionalized nanoparticles and nanomaterials as systems that can control the peptide assembly. The current work provides an exciting platform to enable these studies.

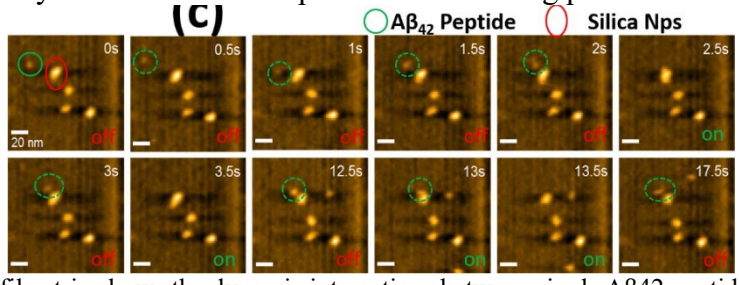

Figure 1: HS-AFM filmstrip shows the dynamic interactions between single Aβ42 peptide and silica nanoparticle. Scale bar: 25nm. Video rate :2frames/sec.

References:

[1] Nel, Andre E., et al. "Understanding biophysiochemical interactions at the nano-bio interface." *Nature Materials* 8.7 (2009): 543.
[2] Ando, Toshio, Takayuki Uchihashi, and Takeshi Fukuma. "High-speed atomic force microscopy for nano-visualization of dynamic biomolecular processes." *Progress in Surface Science* 83.7 (2008): 337-4