Functionalization of Polymeric Beads as Optical Reporters of Biomembrane Mimicking Cell Substrate Properties

Leandro Moretti[1], Daniel E. Minner[2], Vincent L. Herring[3] and Christoph A. Naumann[3]
[1]Department of Biomedical Engineering, Purdue School of Engineering and Technology; [2]Nanosystems Development Institute (INDI) of IUPUI; [3]Department of Chemistry and Chemical Biology, Purdue School of Science

Novel biomembrane-mimicking cell substrates based on a polymer-tethered multi-lipid bilayer stack have been recently developed in the Naumann lab. These novel substrates have been shown to induce profound changes in cellular behavior dependent on the number of bilayers in the stack. However, the underlying mechanical substrate properties remain unclear. To overcome this problem, the central goal of my research is the development of a nanoparticle-based optical reporter that provides insight into the dynamic and viscoelastic properties of the multibilayer system. To achieve this goal, fluorescent polystyrene beads and magnetic polystyrene beads were functionalized for use in confocal microscopy and magnetic tweezers (MT) assays, respectively. Both kinds of beads were specifically tailored and functionalized to link the bilayer system to cellular adhesion proteins recognized by plated cells, thus acting as fluorescent cell-substrate linkages. To assure the correct surface functionalization of nanoparticles, Zetasizer assays were run on both kinds of beads to verify expected changes in hydrodynamic radius and zeta potential as reactions progressed. Fluorescent beads were specifically linked to lipid bilayers using maleimide-thiol coupling chemistry, thus allowing subsequent experiments in the presence of plated cells. As confirmed by analysis of cellular nanoparticle uptake, the cellular uptake kinetics of the newly synthesized fluorescent beads could be controlled through adjustment of nanoparticle coating composition. These results are significant because they validate the new nanobead design, which shows enhanced reporter efficiency for confocal microscopy and MT based assays.

Mentor: Christoph A. Naumann, Department of Chemistry and Chemical Biology, Purdue School of Science, IUPUI