Using Patchy Surfaces for Selective Particle and Cell Adhesion and Dynamic Motion Control

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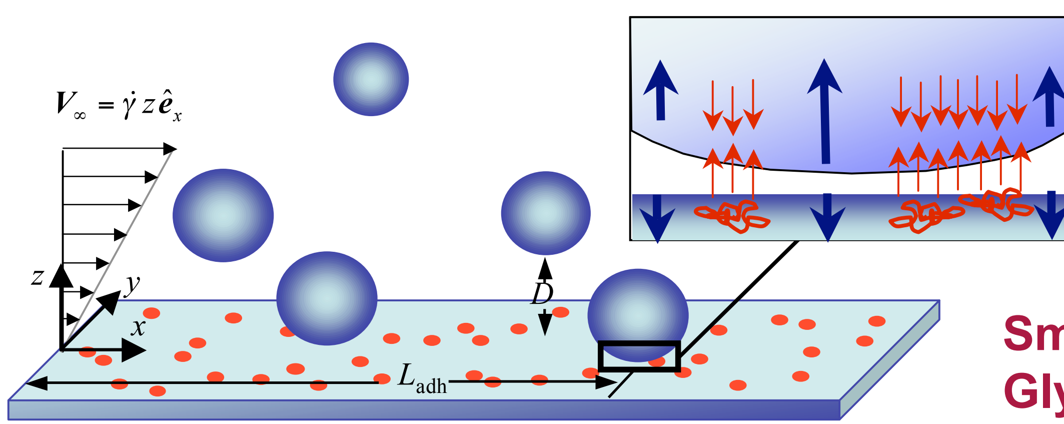
Randomly Patchy Surfaces

- appear commonly in nature (minerals, bacteria cells)
- involve a broad distribution of lenth scales, functionalities
- heterogeneities (and non-average surface characteristics) can dominate adhesive behavior

Random Surface Heterogeneities Can be Engineered to

- bind target particles with sharp selectivity
- separate mixtures of particles
- manipulate the dynamic adhesion of target particles
- direct adhesive particle motion (rolling, skipping, arrest, sliding)
- maintain sustained particle rolling in flow on microfluidic elements

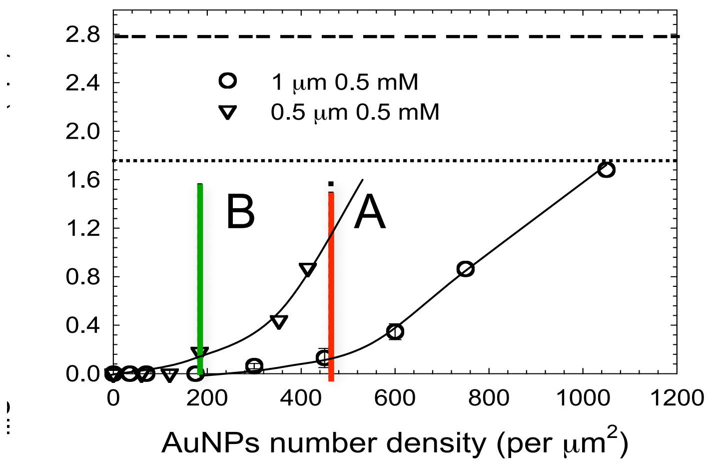
Localization of Attractions



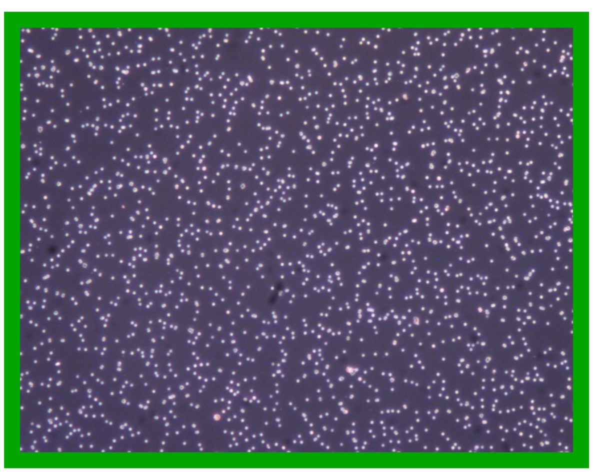
Small "receptors"
Glycocalyx "field"

Using Randomly Heterogeneous Surfaces for Selective Particle Capture

(with out use of biomolecular fragments such as antibodies, DNA)



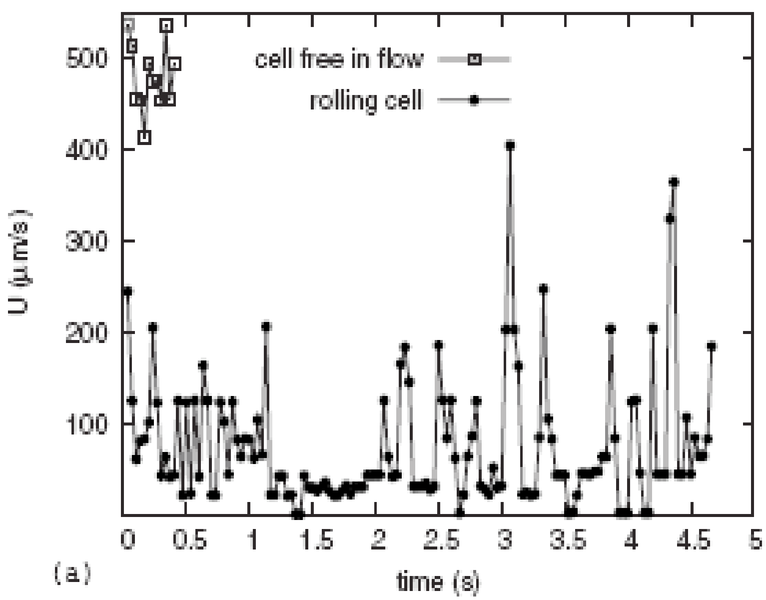
Here a mixture of microspheres is flowed over a heterogeneous surface containing a specific amount of cationic nanoparticles. A control surface adheres all the microparticles while the engineered surface adheres only the targeted population.



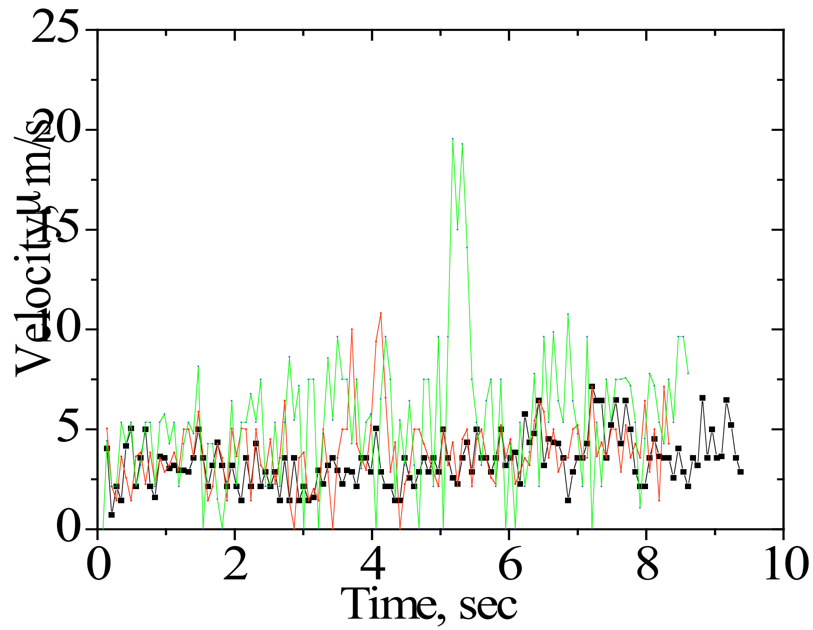
More sharply curved particles captured with nearly perfect specificity

Using Randomly Heterogeneous Surfaces for Control of Dynamic Particle Adhesion and Rolling

Leukocytes: L-selectin vs Silica Particles: Cationic Patches



Alon, Chen, Prui, Finger, Springer
J. Cell Biol. 138 (5) 1169-1180



Here, at very specific engineered surface conditions microparticles and bacteria roll on electrostatically heterogeneous surfaces, but do not arrest or escape.

Read More:

Using Heterogeneities for Selective Particle Adhesion:

- "Micrometer Scale Adhesion on Nanometer-Scale Patchy Surfaces: Adhesion Rates, Adhesion Thresholds, and Curvature-Based Selectivity " N. Kozlova and M.M. Santore,* *Langmuir*, 23, 4782-4791 (2007).
- "Beyond Molecular Recognition: Tuning Interfacial Valency for Micron-Scale Specificity between Adhesive Surfaces" M.M. Santore,* J. Zhang, S. Srivastava, and V.M. Rotello *Langmuir*, **25**(1) 84-96 (2009).

Mechanisms of Interaction at Heterogeneous Interfaces:

- "The Impact of Nanoscale Chemical Features on Micron-Scale Adhesion: Crossover from Heterogeneity-Dominated to Mean Field Behavior" R. Duffadar, S. Kalasin, J.M. Davis, and M.M. Santore*, *Journal of Colloid and Interface Science* **337**(2) 396-407 (2009).

Flow Effects on Heterogeneity-Mediated Adhesion:

- "Hydrodynamic Crossover in Dynamic Microparticle Adhesion on Surfaces of Controlled Nanoscale Heterogeneity" S. Kalasin and M.M. Santore,* *Langmuir*, 24, 4435-4438 (2008).
- "Manipulating Microparticles with Single Surface-Immobilized Nanoparticles" J. Zhang, S. Srivastava, R. Duffadar, J.M. Davis, V.M. Rotello, and M.M. Santore,* *Langmuir*, **24**, 6404-8 (2008).

Heterogeneities in BioAdhesion and Biomaterial Design:

- "Non-Specific Adhesion on Biomaterial Surfaces Driven by Small Amounts of Protein Adsorption" S. Kalasin and M.M. Santore*, *Colloids and Surfaces B: Biointerfaces* **73**(2) 229-236 (2009).