Anisotropic Spiky Colloids for Antifouling Surfaces

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Motivation

Fouling is the accumulation of contaminants on a surface. Fouling reduces surface efficiency and can cause contamination, impacting several industries such as medical, maritime, and space.\textsuperscript{2,3}

Our approach uses the assembly of anisotropic spiky colloids to fabricate antifouling surfaces to repel the broad range of shapes and sizes of fouling materials.

Objective: Characterize the assembly of anisotropic spiky colloids of differing spike size and distribution over a planar surface to repel fouling materials of different shapes and sizes.

Methodology

Particle morphology and spike distribution

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<th>n = 1.4</th>
<th>n = 2</th>
<th>n = 4</th>
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<td><img src="https://example.com/figure1.png" alt="Particle Morphology 1" /></td>
<td><img src="https://example.com/figure2.png" alt="Particle Morphology 2" /></td>
<td><img src="https://example.com/figure3.png" alt="Particle Morphology 3" /></td>
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Random Sequential Adsorption, or RSA, is a process in which particles are randomly introduced to a system. If a particle is placed on the surface where there is not already a particle, it adsorbs and remains fixed for the duration of the simulation.

Figure 1. (a) European common blue butterfly wing (\textit{P. icarus}) at 50\textmu m, and (b) a giant blue morpho wing (\textit{Blue Morpho didius}) showing superhydrophobic and anisotropic flow properties.\textsuperscript{2}

Figure 2. Particles schematics with a cube spike distribution with varying superellipsoid parameters, ranging from n= 1.4 to 4, \( r_1 = r_2 = r_3 = 1.0 \).

Figure 3. Representative plot of random adsorption of particles at different steps, represented in the insets.

Roughness

\[ \sigma = \frac{1}{N} \sum_{i=1}^{N} \left( \frac{1}{N} \sum_{j=1}^{N} d(i,j) \right) \]

Figure 4. A set of particles with the peaks, valleys, and midline outlined alongside the equation used to find average roughness.

The pair correlation function characterizes the particle configuration/structure by measuring the probability of finding the center of a particle at a distance from another particle, which is defined by

\[ g(r) = \frac{V}{4\pi r^2 N} \sum_{i=1}^{N} \sum_{j=1}^{N} \delta(r - d(i,j)) \]

Figure 5. Comparison of Random Sequential Adsorption curves of different aspect ratios (a) \( n = 1.4 \), (b) \( n = 2 \), and (c) \( n = 4 \).

Figure 6. Roughness of adsorbed particle structures using spiky particles with a superellipsoid parameter (a) \( n = 1.4 \), (b) \( n = 2 \), and (c) \( n = 4 \).

Pair correlation function

Figure 7. The pair correlation function of adsorbed particle structures, with superellipsoid parameters (a) \( n = 1.4 \), (b) \( n = 2 \), and (c) \( n = 4 \).

Conclusions and Future Work

- The maximum number of adsorbed particles decreases as particles aspect ratio increases. Furthermore, the number of adsorbed particles decreases as the shape parameter (n) increases.
- The average roughness increases as the spike shape parameter increases. But the particle-particle separation decreases.
- We create representative 3D-printed models of the particles studied.
- In the future we will study more aspect ratios and particle morphologies and begin adding multi-scale fouling particles.

References


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