Your Paper

You

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Abstract

Your abstract.

1 Introduction

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2 Derivation

2.1 τ_{ij} Transnational Search Time

$$J_{ij} = k_{ij} c_i c_j$$

where

$$k_{ij} = 4\pi(i+j) D_{ij} c_i c_j$$

where i,j the radius of two interacting particles we are considering, D_{ij} is the effective transnational diffusion constant defined as

$$D_{ij} = D_i + D_j \tag{1}$$

$$= \frac{k_B T}{6\pi i \mu} + \frac{k_B T}{6\pi j \mu} \tag{2}$$

Thus,

$$k_{ij} = \frac{2k_B T}{3\mu} \frac{(i+j)^2}{ij}$$

$$J_{ij} = \frac{2k_B T}{3\mu} \frac{(i+j)^2}{ij} c_i c_j$$

this is number of collision per sec per square meter, to find the time τ_{ij} for each collision (time for origami to meet within their interactive region), take inverse

$$\tau_{ij} = \frac{3ij\mu}{2k_B T (i+j)^2} \frac{1}{c_i c_j}$$

2.2 τ_s Rotational Search Time

$$\tau_s = \frac{1}{D_\theta} \frac{ln4}{\alpha} \times \frac{1}{6}$$

$\frac{1}{6}$ account for 6 sticky ends, this is not accurate, just a rough approximation. $\alpha = \frac{\pi r_c^2}{2\pi r^2}$ is the relative capture surface, in our case, it can be approximated as following

$$\alpha = \frac{\frac{1}{\sqrt{2}}(l + \frac{Rg}{2})R_g}{(l + \frac{Rg}{2})^2 2\pi} \tag{3}$$

$$\approx \frac{2}{3\sqrt{2}} \tag{4}$$

D_θ is the effective rotational diffusion constant, which can be computed as

$$D_\theta = D_{\theta i} + D_{\theta j} \tag{5}$$

$$= \frac{k_B T}{8\pi\mu}(\frac{1}{i^3} + \frac{1}{j^3}) \tag{6}$$

$$= \frac{k_B T}{8\pi\mu}\frac{i^3 + j^3}{i^3 j^3} \tag{7}$$

Therefore

$$\tau_s \approx \frac{1}{D_\theta}\frac{ln4\sqrt{2}}{3}\frac{1}{6} \tag{8}$$

$$= \frac{4\sqrt{2}ln4\pi\mu}{9k_B T}\frac{i^3 j^3}{i^3 + j^3} \tag{9}$$

2.3 τ_c Collision Time

This is the time for two origami to remain in active range. Simply using

$$x = \sqrt{6D_{ij}\tau_c}$$

and set distance $x = 5nm$, which is approximately two third of the length of the sticky end plus Ts.

$$\tau_c = \frac{H\pi\mu}{k_B T}\frac{ij}{i+j}$$

where $H \approx 2.5 \times 10^{-17} m^2$.

2.4 τ Total Time For Two Origami To Combine in $1m^3$

$$\tau = \tau_{ij}(1 + \frac{\tau_s}{\tau_c}) \tag{10}$$

$$= \frac{3\mu}{2k_B T}\left(\frac{ij}{(i+j)^2} + \frac{4\sqrt{2}ln4}{9H}\frac{i^3 j^3}{(i^3+j^3)(i+j)}\right)\frac{1}{c_i c_j} \tag{11}$$

$$= \frac{1}{M}\left(\frac{ij}{(i+j)^2} + N\frac{i^3 j^3}{(i^3+j^3)(i+j)}\right)\frac{1}{c_i c_j} \tag{12}$$

where $M = \frac{2k_B T}{3\mu}$, $N = \frac{4\sqrt{2}ln4}{9H}$ are constant. Then, we can obtain the collision rate per meter squared per second by simply take reciprocal of tau

$$n(i,j) = \left(\frac{M(i+j)^2}{ij + N\frac{i^3 j^3 (i+j)}{(i^3+j^3)}}\right)c_i c_j$$

where

$$k(i,j) = \frac{M(i+j)^2}{ij + N\frac{i^3 j^3 (i+j)}{(i^3+j^3)}}$$

is the kernel we want.

References