Anisotropic thermophoresis of colloidal rods: microscopic geometry matters

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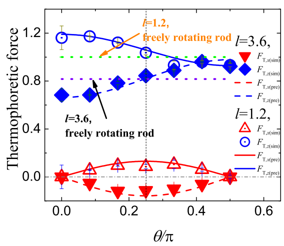
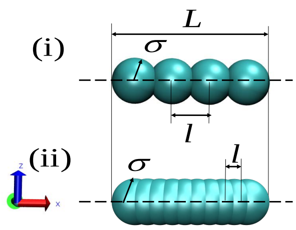
Colloidal migration in temperature gradient is referred to as thermophoresis. In contrast to particles with spherical shape, elongated colloids may have a thermophoretic response depends on colloid orientation, and more interestingly a non-vanishing thermophoretic force can be induced in a direction perpendicular to the temperature gradient [1]. By means of mesoscale hydrodynamic simulations, we investigate anisotropic thermophoresis of rod-like colloids.

The anisotropic thermophoretic effect can be characterized by two orthogonal thermal diffusion factors, which determine, by linear decomposition approach, the thermal diffusion factor in arbitrary orientation (Fig.1a). In dilute limit, this linear combination relation explains that the temperature gradient induces no alignment in the rods, and shows that the thermophoretic force increases monotonously with the rod length. Rods are constructed by the so-called 'shish-kebab' model what allows us to vary the surface geometry. Remarkably, the degree of anisotropy can be changed, or even reversed by tuning rugosity (Fig.1). This can be understood since the local microscopic geometry induces different interfacial temperature gradients what results in diverse surface mobilities of colloid. Our study shows that the anisotropic thermophoresis may be controllable by interfacial tunability [2]. This anisotropic effect of thermophoresis has shown to be the basic mechanism that allows the construction of thermophoretic turbines, which move in the presence of an external temperature gradient [1].



(a)



(b)

FIG. 1: (a) Thermophoretic forces measurement of rods with different orientations. (b) Schematic representation of model of rods. Rugosity can be differed by tunning number of beads and rod length.

[1] M. Yang, R. Liu, M. Ripoll, K. Chen. *Nanoscale*, **6**, pp. 13550-13554, 2014.
[2] Tan, Z., Yang, M. and Ripoll, M., *in prep*.

☑ Oral Presentation ☐ Poster Presentation