

Rheology of bacterial suspension

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Antibiotic resistance-- the microbial evolution of mechanisms that protect bacteria from antibiotic effects-- is a global concern as mortality rates resulting from common infections caused by multi-drug resistant bacteria are ever increasing. Treatment failure is often the consequence of sub-populations of cells that become resistant or tolerant to the antibiotic pressure. Many parameters influence the outcome, such as presence of other microorganisms, the host immune system or nutrient limitations. One method to identify the bacteria resistance is through the cell stiffness. Several studies with AFM (atomic force microscope) focuses on how antibiotic exposure alters cellular membrane rigidity by determining the elasticity of ampicillin resistant strains of *E. coli* over several generations grown in increasing concentrations of antibiotic. **This procedure only accounts the properties at cellular level but not the effect that stiffness in the collective behavior of the bacterial suspension.** To study the cell stiffness as macroscopy quantity we can use rheology.

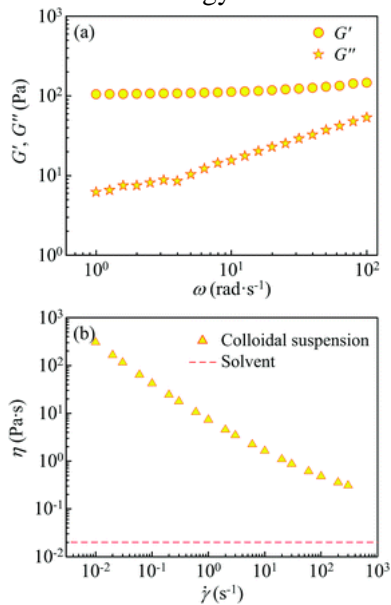


Figure 1. Rheological measurements of the charge-stabilized colloidal suspension. (a) Frequency dependence of the storage and loss moduli G' and G'' . (b) Shear viscosity η as a function of shear rate $\dot{\gamma}$.

Project 1: Rheology of bacterial suspension

Bacteria *E. coli* will be cultured using standard practices before the stepwise addition of ampicillin across an estimated 10 generations. Rheological measurements will be performed in a controlled stress rotational rheometer Anton Paar (i) flow curve: a steel cone and plate geometry for the steady-state shear flow tests, which will be performed at room temperature. This process will be repeated for an estimated ten (10) generations, increasing ampicillin concentration by two-fold for each subsequent culture. The experimental information like the shear stress, shear viscosity and shear modulus will be use with simulation results to obtain an accurate model. Figure 1 we show an example of the information that can be obtained with the rheometer.

Project 2: Active Brownian simulation under shear flow

We propose a simple model for Brownian motion of a micro swimmer under shear steady flow. To describe the motion of the *E. coli* bacteria, we need to modify the Langevin equations to include the velocity of bacteria and external force create for the rheometer. Dumbbells and hard repulsive interaction will be used as initial parameters to describe the shape and interaction between the bacteria. The code will be built in Python or Fortran. Simulations need to run with a large number of particles and longer period of time to get good statistics. To perform this massive simulation will require to use of UTC SIMCENTER computer cluster. Properties as shear stress, shear viscosity and shear modules can be obtained from simulation and compare quantitative and qualitative with experimental results from rheometer.