Microrheological investigation of a biofilm and its constituting extracellular polymers

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We utilize passive microrheology to understand the origin of viscoelasticity in a bacterial biofilm by measuring the mechanical properties of its individual constituents using thermally driven microspheres as probes. Biofilms are a biological soft matter consisting of bacterial aggregates embedded within an extracellular polymeric hydrogel. Owing to their composite microstructure, the bulk mechanical properties are likely due to a synergistic response of cells and polymers, which occur at very short temporal and spatial scales, thus requiring the use of microrheology to access this feature. Using a model bacterial biofilm formed by *Staphylococcus epidermidis*, we show that the biofilm's creep compliance can be viewed differently at short and long time scales. The short time response was found to be governed by a composite polymer system consisting of the biofilm's extracellular polymers. Microrheology measurements on biofilms show that the long time plateau in creep is due to the presence of large bacterial clusters. Comparison of these studies with recently published data obtained from conventional bulk measurements show good agreement at long times, thus confirming our approach. Furthermore, the viscous modulus of the biofilm was found to be due to the extracellular polymers while the origin of elasticity couldn't be evinced clearly. Due to the detrimental prevalence of biofilms in a variety of environments, studies in this direction is well suited to understand their sustenance, yielding and subsequent fracture under different shear conditions.