Timescales of emulsion formation caused by anisotropic particles
Florian Günther¹, Stefan Frijters¹ and Jens Harting¹,²

Abstract
Particle stabilized emulsions have received an enormous interest in the recent past, but our understanding of the dynamics of emulsion formation is still limited. For simple spherical particles, the time dependent growth of fluid domains is dominated by the formation of droplets, particle adsorption and coalescence of droplets (Ostwald ripening), which eventually can be almost fully blocked due to the presence of the particles. Ellipsoidal particles are known to be more efficient stabilizers of fluid interfaces than spherical particles and their anisotropic shape and the related additional rotational degrees of freedom have an impact on the dynamics of emulsion formation [1,2]. Here, we investigate this point by means of simple model systems and combined multicomponent lattice Boltzmann and molecular dynamics simulations [3,4,5,6].

Emulsions stabilized by anisotropic particles

- Depending on parameters such as fluid ratio, particle volume concentration C, contact angle θ and aspect ratio m, the system can evolve into a Pickering emulsion (PE) (left) or a bicontinuous interfacially jammed emulsion gel (bija) (right) [2,3,7,8,9].
- Here, the control parameter is the fluid ratio. It is chosen 5:2 for the PE and 1:1 for bijels.

Time-dependent collective ordering
- Pair correlation function [2,5]:
  \[ g(r) = \frac{1}{2\pi} \int_0^{\infty} \frac{1}{2} \delta(\tilde{r} - t_0) \, d\tilde{t} \]
- Height of the first peak of \( g(r) \) depends on the area coverage fraction χ.
- Time development of the first peak of \( g(r) \) related to particle ordering.
- Order of \( 10^5 \) timesteps \( \rightarrow \) Timescale I.
  \( \Rightarrow \) Two additional timescales are identified.

Conclusion
We demonstrated that the anisotropic shape of ellipsoidal particles causes two additional timescales to be of relevance in the dynamics of emulsion formation: a relatively short timescale can be attributed to the adsorption of single particles and the involved rotation of particles towards the interface. As soon as the interface is jammed, however, capillary interactions between the particles cause a local reorderding on very long timescales leading to a continuous change in the interface configuration and increase of interfacial area. This effect can be utilized to counteract the thermodynamic instability of particle stabilized emulsions and thus offers the possibility to produce emulsions with exceptional stability.

Acknowledgments
Financial support from the NWO-STW (SID grant of J. Harting) is gratefully acknowledged. We thank the Jülich Supercomputing Centre for the technical support and the CPU time which was allocated within a large scale grant of the Gauss Center for Supercomputing.

References