Université franco-allemande
Deutsch-Französische Hochschule

Red blood cells (RBCs) are micron sized biological objects and the main corpuscular constituent of blood. It flows from larger arteries to very small capillaries. Utilizing a physical approach, this work aims to assess properties that govern blood flows and in particular the disaggregation and aggregation mechanisms of RBCs at a single cell level. The interactions of RBCs are thus, investigated experimentally by measuring adhesive forces, which are only a few piconewtons, in various model solutions thanks to optical tweezers. While two models for aggregation have been proposed: bridging and depletion, experimental evidence is still lacking to decide which mechanism prevails. The research presented here provides a new insight on the aggregation of RBCs and shows that the two models may not be mutually exclusive. A complete 3-dimensional phase diagram of doublets has been established and confirmed by experiments by varying the adhesive forces and reduced cell volumes. Besides, the effect of aggregation was studied in vitro in a bifurcating microcapillary network and the distribution of aggregates and their stability in such a geometry are reported. Finally, experiments in flow allowed the characterization of the flow field around single RBCs at different velocities. Interesting vortical fluid structures have been also observed thanks to tracer nanoparticles.