Université franco-allemande
Deutsch-Französische Hochschule

Kollektive Effekte von Blutlösungen

Summary

Chachanidze Revaz

Blood is a dense biological suspension. Around 40% to 50% of blood volume is represented by red blood cells (RBCs), 0.5-1% is formed by other suspended particles such as white blood cells (WBCs) and thrombocytes (platelets). The medium of the suspension is a Newtonian fluid called plasma. The rheological behaviour of blood is primarily determined by RBCs, whose main biological function is the maintenance of gas exchange in the body. The physiological importance of blood and the complexity of its rheological behaviour has been attracting researches to this field of study for decades.

Among many particular phenomena taking place in hemodynamics, it is margination that causes interest of researches in recent years. Margination can be described as the ability of certain suspended particles to travel from bulk flow to vessel wall. In blood, this phenomenon of cells segregation plays a crucial physiological role. It ensures the presence of leukocytes close to vascular endothelium which allows their adhesion and further migration to the inflammatory sites. Near-wall enrichment of platelets concentration is believed to be associated with fast blood clot formation and edothelial repair. Additionally, in case of certain diseases when mechanical properties of red blood cells were altered, those cells as well show the affinity of lateral migration in flow. Moreover, recent advances in targeted drug delivery arouse the interest in margination of drug carriers. The mechanisms leading to margination are not fully understood and very few experimental works have been performed, especially considering margination in 3D flow.

This work was carried out in collaboration between I.R.P.H.E. (Institut de Recherche sur les Phénomènes Hors Équilibre), research unit of Aix-Marseille University and University of Saarland, Faculty of Experimental Physics (Naturwissenschaftlich-Technische Fakultät der Universität des Saarlandes) and aims

to investigate microcirculatory hydrodynamics of blood *in vitro*. The study is dedicated to better understanding of complex collective phenomena that take place in microcirculation of blood through microfluidic *in vitro* experiments. It mainly focuses rigidity based margination in suspension of RBCs. For this purpose, model experiment was developed to examine margination caused exclusively by contrast of deformability between two sub-populations of RBCs.

This thesis is organized as follows. A short overview of the state of the art about margination and the objectives of this work, including a theoretical explanation, are presented in the introduction. The second chapter is dedicated to general materials and methods, that were employed in the course of this study. The third chapter describes techniques designed in order to control experimental parameters of this study. The fourth chapter is dedicated to the several studies about rigidity based margination. In the fifth chapter we discuss an original method of analysing shapes of individual RBCs. The last chapter is dedicated to conclusions where we will summarize the results of this work.