Master 2 - SBCP
Internship 2022-2023 (4 months full time, can be started part time)

Microstructure and mechanics of blood clot

Supervisor:

Name: Jean-Marc ALLAIN
Phone: 0172925940
E-mail: jean-marc.allain@polytechnique.edu

Host Laboratory:

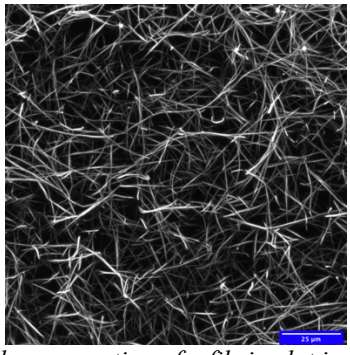
Affiliation: Ecole polytechnique / CNRS
Lab Name : Laboratoire de Mécanique des Solides
Address : Route de Saclay, Palaiseau

Partners or collaborations :

Name: Nathalie Westbrook
Affliliation: Institut d'Optique Graduate School
Lab Name : LCF - IOGS
Address : 2 avenue Fresnel, Palaiseau
E-Mail : nathalie.westbrook@institutoptique.fr

Project description :

Venous blood clots are responsible for thrombosis, which can degenerate into pulmonary embolism, affecting about 60 out of every 100,000 people per year. Venous thromboses are due to an alteration in hemostasis. They can result either from stasis (alteration of blood flow), or from an alteration of the vascular wall, or from hypercoagulability (alteration of coagulation factors of the blood). All of these effects promote the formation of a blood clot that may break off from the vein at some point and flow into the pulmonary artery and block it (at least partially). Now-a-day, only 50% of the thromboses can be explained, due to the lack of simple efficient diagnosis tools.



Example of an optical cross-section of a fibrin clot in confocal microscopy.

We are developping a new approach to study the hypercoagulability by studying the mechanical properties of blood clots in relation with its microstructural organization. Indeed, a clot is mainly

formed by the polymerization of a fibrin network. Any modification in the factors of the coagulation will lead to a modification in the polymerization condition, which will then affect the fibrin network structure. However, microstructure observation is complex, as fibrins are very thin. Thus, a simpler alternative is to measure the associated mechanical properties: an alteration in the network organization will induce an alteration of the mechanical properties.
Our project is thus to perform rheological measures, using a local approach trackings beads embedded in the clot, on clots mimicking normal clots or clots with hypercoagulability conditions. These measures can be correlated to observations of the clot microstructure under the same conditions. We have performed preliminary observations, which show that large excesses of the coagulation factor VIII (associated one thrombotic condition) leads to a stiffening of the clot, together with a decrease of the fibrin length.
Together with our hospital partners, we would like to understand how the clot mechanical properties and structures are modified under known thrombotic (or hypercoagulation) conditions. To do so, the first step will be to improve the protocol of microrheological measurment, so that it can be use routinely on a statistically-significant number of clots. Then, we will add known coagulation factors to healthy clots, so that we can determine how each factor affects the structure and the mechanical properties. On the long term, these results will be applied to clots from patients, with known diseases (and, at some point in the future, unknown ones as a diagnosis tool).

The internship may be followed by a PhD (already funded by an ANR project).