Internship M2: Impact of particle roughness on deposition and clog formation in a porous medium.

The retention of objects during the transport of a suspension within a porous medium is a problem that affects many domains. It can occur during the infiltration of water in a soil by plastic fragments, be at the origin of blood clots in the body, the cause of the clogging of filter to purify the air or treat water. In narrow constrictions, this retention of particles is at the origin of the creation of clogs (figure 1).

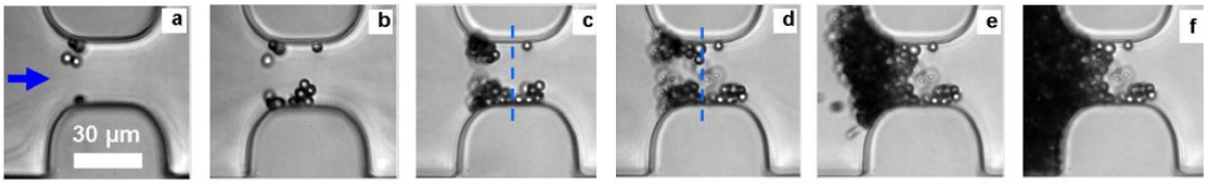

Figure 1: formation of a clog by colloidal particles of polystyrenes of diameter 4µm [1].

Several studies have shown that the shape and size of objects play a major role during their deposition on a surface [2]: the more complex the shape of the object, the greater its capture (Fig. 2B). These studies are based on the use of commercial colloidal particles with negligible surface roughness, which is not the case for nano and microplastics in the environment, as they have many roughnesses. Recently, it has been shown that these roughnesses seem to play an important role in the clogging process [3], but this effect remains little studied and quantified.

During this course, we will fabricate micrometric particles with a controlled roughness at the nanometer scale (fig. 2A). This fabrication is very simple and is based on mixtures of particles with two different sizes. We will then study the transport of these rough objects in straight microfluidic channels to determine their deposition properties on the channel surface as a function of flow and roughness. We will then consider plug formation with such particles in a single pore/constriction (Fig. 2b) and then in a porous medium (Fig. 2C).

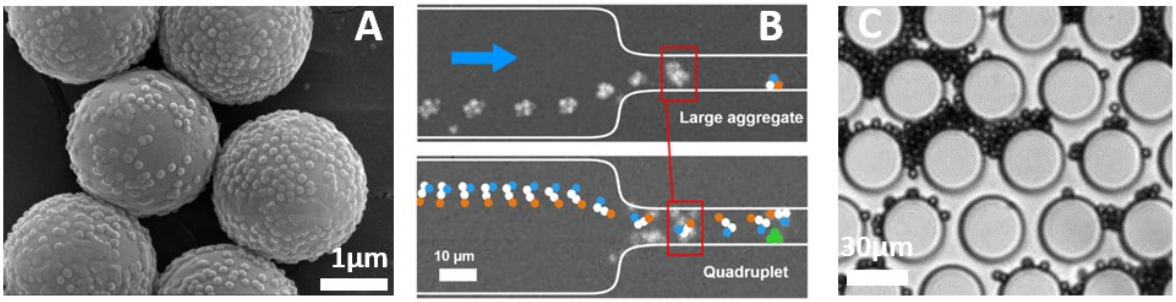

Figure 2: (A) Particles of 1.5µm covered by nanoparticles of 50nm. (B) Particle capture dynamics in a constriction/pore. (C) Clogging of a two-dimensional porous medium by 5µm diameter colloids.

This internship is essentially experimental and will allow the trainee to learn microfluidic techniques, microscopy and image analysis. Basic knowledge of colloidal suspension physics is useful but not necessary.

Profile: The candidate must be curious, dynamic and rigorous. Knowledge in programming and image processing (Matlab, Python or other) would be a plus. This internship will take place at the Institute of Physics of Rennes from January 2023 or later under the supervision of Nolwenn Delouche and Hervé Tabuteau.

Level : M2 in physics, materials, environment or physical chemistry.

Contacts : nolwenn.delouche@univ-rennes1.fr and herve.tabuteau@univ-rennes1.fr

[1] Dersoir, B. et al. (2015). Clogging of a single pore by colloidal particles. *Microfluidics and Nanofluidics*, *19*(4), 953-961.
[2] Delouche, N. et al. (2020). Dynamics of progressive pore clogging by colloidal aggregates. *Soft Matter*, *16*(43), 9899-9907.
[3] Hsu, CP. Et al.(2021). Roughness-dependent clogging of particle suspensions flowing into a constriction. *Soft Matter*, *17*(31), 7252-7259.