Internship Master 2

"3D printing of yield stress fluids"

The basic process used in additive manufacturing for construction (see Figure 1a) is the extrusion from a certain height followed by deposition of a filament of yield stress fluid (typically a cement paste) on a surface in translation with respect to the print head. Depending on the values of the different parameters (extrusion velocity, translation velocity, height, yield stress, etc) the filament can be deposited in several regimes, which can lead to new strategies for printing yield stress fluids if the deposition mechanisms are understood. In particular various original instability patterns appear when decreasing the extrusion velocity (see Figure 1b): filament breaking regime (I), straight deposition regime (II), deposition regime in the form of meanders (III) or other more complex patterns (IV and V). Our objective is to properly characterize these regimes and understand the conditions of transition from one regime to another, which will allow to precise the most appropriate material and process parameters in practice.

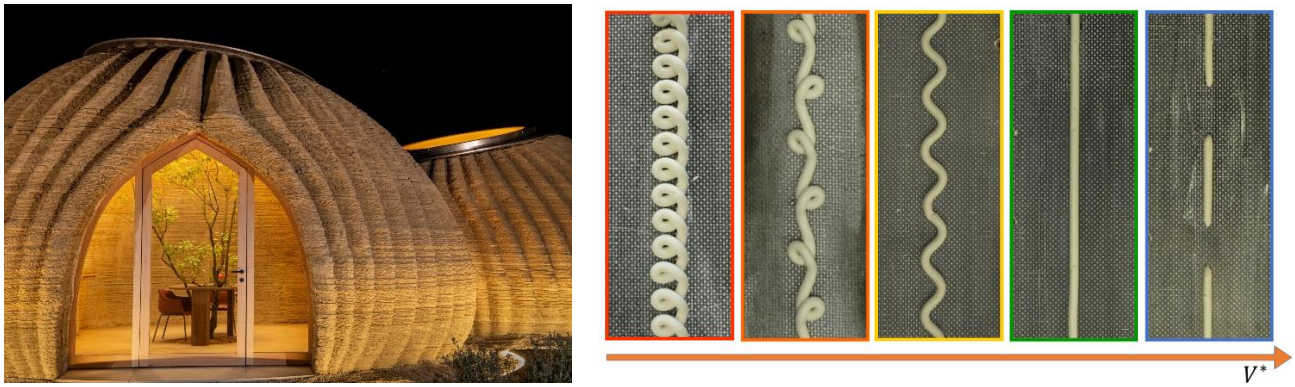

Figure 1: (a) Tecla house, 3D printed raw earth (Mario Cucinella); (b) Main flow regimes (see text) in simple printing process of a kaolin paste as a function of the extrusion velocity.

During this internship, half the work will consist to carry out such experiments on a few model yield stress fluids (emulsion, cement paste, clayey mud), with the help of a special set up of Laboratoire Navier, which allows to control precisely and independently the rate of extrusion, the height of extrusion, and the velocity of translation. The other part of the work will consist to analyze the videos of the experiments, from which the stress and the strain rate distribution can in general be deduced, and propose some theoretical model to predict the transition between some regimes.

Reference: A. Geffrault, H. Bessaies-Bey, N. Roussel et P. Coussot, « Extensional Gravity-Rheometry (EGR) for yield stress fluids », Journal of Rheology 65, 887-901 (2021)

Practical Information:

Desired profile: Background in physics, mechanics or material science.

Dates: from March to July or August 2022

Location: Laboratoire Navier, Equipe Rhéophysique et Milieux Poreux, Bâtiment Bienvenue, Champs sur Marne

Gratification: about 600 euros/month

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