Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes the PhD subject and supervisor proposed by the French Polytech network of 14 university engineering schools. Please contact the PhD supervisor by email or Skype for further information regarding your application.

Supervisor information	
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PhD information	
Title	**Modeling and predicting the collapsing of hydrogels using artificial intelligence method**
Main topics regards to CSC list (3 topics at maximum)	Biomaterials and polymer materials ; Environmental behavior and failure of materials; Biomedical engineering

Required skills in science and engineering	Chemical Engineering, Physics, or Material Science disciplines

Subject description (two pages maximum)

Project title: Modeling and predicting the collapsing of hydrogels using artificial intelligence method

Key words: physical gel, aggregation and gelation, dynamic, rheology, correlation function

Context of the PhD project:

Hydrogels are soft materials since they exhibit properties between liquid and solid materials **[1]**. Because of its soft behavior, gels are widely used by many companies to manufacture goods and biomimetic products. Those made of biopolymers in aqueous phase serve also as growth media for microorganism and cell in tissue engineering and medical diagnostic **[2]**. However, many of biopolymers hydrogels are prone to collapsing and self-drying above all if the concentration in solid material is weak **[3, 4]**. To anticipate collapsing of hydrogels during storage, the manufacturers use different compounds some of them are named stabilizers and are unclean from consumers opinion who are nowadays careful with product compositions. In some cases, the stabilizers in the hydrogel may not be appropriated for microorganism growth or can interfere with the medical testing. Self-drying as a consequence of collapsing is a challenge for companies business since it costs a fair amount of money due to costumers return. This project aims to investigate the physical origin of gel collapsing by modeling its relation with gels elasticity through data-driven techniques **[3, 5]**.

Scientific background:

Thermodynamic stability of polymer solutions as described by Flory-Huggins theory is determined by the equilibrium factors such as the absolute temperature and polymer concentration including the polymer counter ions if any with the presence of solutes that characterize the solvent quality **[6, 7]**. As such, the equilibrium of polymer solutions or particle suspensions implies appropriated selections of these equilibrium factors. Setting the right physico-chemical conditions to have an indefinite time of equilibrium, stand for the difficulty of making suspensions. If the setting of physico-chemical conditions is not done properly, this will lead to either multi-phase or metastable equilibrium. In the latter condition fluctuation effects like for instance temperature and concentration fluctuations may lead to demixing which can take several hours or days to happen and generally involve aggregation of the suspension. The aggregation can lead to an interconnected aggregates network whose elasticity can freeze the demixing **[8]**. At the freezing time, the suspension displays both solid-like and fluid-like flow properties. The suspension can only flow when a large enough stress, greater than the yield

stress, is applied. Aggregation and gelation of hydrocolloids are mostly encountered in food engineering where biopolymers are used as gelling agents, in biotechnology where these gels serve as growth media for microorganisms or as porous scaffolds for tissue engineering but also in engineering processes to form high performance material such as porous ceramic materials, air cleaning materials, 3D printable gel materials and film coating **[2]**. As mentioned in the context, these gels are out of equilibrium and can collapse **[9].**

References

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