PhD Proposal 2017

School: Ecole Centrale Marseille	
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Collaboration with other partner during this PhD: In France:	In China:

Title: Optimizing microfluidics for microencapsulation applications
Scientific field: chemical engineering
Key words: microencapsulation, emulsification, microreactor, microfluidics

Details for the subject:

Background, Context:

Microcapsules are small particles containing an active substance, surrounded by a thin polymer shell. Sometimes this thin polymer shell acts as a barrier to mass transfer, inducing a slower and controlled delivery of the active agent; microcapsules are hence used for instance for drug delivery in the pharmaceutical industry, but also for fragances, flavors, inks, and so on. Otherwise, the thin polymer protects the active substance from leaking and interacting with its environment; in that case, microcapsules can be used for instance for the storage of phase change materials, with potential uses in active or pumped coolants, solar and nuclear heat storage systems and heat exchangers.

Microfluidics has a strong potential on microencapsulation processes, since it enables a precise control on microflows, the production of uniform droplets with a narrow size distribution during the emulsification step, as well as an enhanced mass transfer. Previous studies have shown the feasibility of microencapsulation using microfluidics. However, the production rates are low, and a scale-up is still necessary before implementation for industry.

Research subject, work plan:

Microencapsulation study will consider two diferent kinds of operation: an emulsification step in a micromixer, followed by an encapsulation step in a stirred vessel; and both emulsification and encapsulation in a microfluidic device. In both cases, several geometries will be considered.

The research work will take advantage of both a numerical and an experimental approach. Indeed, the Lattice Boltzmann Method will be used to model the emulsification step, which plays a main role on the final microcapsule size. This numerical approach will be validated by fast-camera visualizations. The modeling thus validated could be used to optimize the microchanel design. These complementary approaches should be fruitful when scaling-up microencapsulation processes.

A preliminary work plan can be declined as follows:

1. Bibliography and state of the art
2. Experimental plan design and choice of the chemical products to be used
3. Experimental campaign
4. Modeling
5. PhD thesis redaction

References on this topic:

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