SEMS: RESEARCH PROJECT DESCRIPTION

1. Project Background and Description

Microencapsulation on demand for 3D printing of biomaterials

Encapsulation where a certain substance is surrounded by another compound is of a great interest in different applications such as encapsulation of living cells, drug delivery control and drug protection against acid pH. It can be used also in the field of medical diagnosis to improve the effectiveness and resolution of systems such as PCR (polymerase chain reaction). There are different methods for encapsulation such as emulsion techniques. Other approaches, depend on the control of the formation and the breakup of liquid jets, include electrospray, flow focusing, and electrified coaxial liquid jets. Although these methods have been used extensively over the last decade, none of which managed to combine between all the desired parameters; defined size distribution, control thickness of coating, and produce capsules on demand.

In this project, we aim to develop a novel technique based on the impact of drops on liquid surfaces to generate capsules on demand. The target is to control all the desired encapsulation parameters which is significantly important in medical technology. As an example, the technique could be used to produce identical microparticles with identical properties which will enable tailored and controlled doses release in drug delivery. Also, it could be used in 3D printing of bio-materials. The methodology to carry out this project will depend on experimental and computational tools. Visualization techniques will be used in the experiments to analyze the impact process in order characterize all the parameters affecting on the encapsulation such as the impact velocity, the liquids properties and the droplet size. At the end, a mapping of the operational condition for a successful encapsulation will be established.

2. Project Scope

The objectives of the research project are:

1. *Design and build an experimental setup for the novel encapsulation process.*
2. *Conducting computational modeling of the impact using available open source codes.*
3. *Characterize the parameters affecting the encapsulation process and print bio-structures based on this knowledge.*

3. Desired Skills from the Student

1- *The ideal candidate will have an MSc degree (or equivalent) in Mechanical Engineering, Physics, Mathematics or a related discipline.*

2- *Strong background in fluid dynamics and applied physics.*

3- *Knowledge of biomaterials would be an advantage but not essential.*

4- *Experience of working in a laboratory; conducting experiments and analyzing the results.*

5- *Some basic programing skills.*

4. Supervisory Team

Primary Supervisor: *Dr. Ahmed Ismail, Academic Fellow in Fluid Dynamics*

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Secondary Supervisor: *Dr. Helena Azevedo, Reader in Biomedical Engineering & Biomaterials*

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