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DOCTOR OF ENGINEERING SCIENCES

of **Benoit Thienpont**

The public defense will take place on **Tuesday, 8th June 2021 at 5pm.**

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**SOLVENT EXTRACTION-BASED MICROPARTICLE FABRICATION AND
ITS MULTINOZZLE MICROFLUIDICS UPSCALING**

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Abstract of the PhD research

Microfluidics has seen an important surge in interest. Due to its intrinsic small channel sizes, hence small fabrication volumes, the main interest so far comes from the pharmaceutical sector. Among many potential applications, one is of particular interest, monodisperse microparticle fabrication for controlled drug release.

The overall concept is based on solvent droplets, of all the same size, containing a dissolved polymer and a drug load. When collected in another partial solvent phase, the solvent of the droplets slowly dissolve into the surrounding phase, leaving behind the insoluble polymer spheres containing the drug. If selecting a bio-compatible and bio-degradable polymer as poly(lactic-co-glycolic acid) (PLGA), which disintegrates slowly upon contact with body fluids, its drug load is released in a controlled manner.

Many reports mention the use of toxic dichloromethane as a solvent for PLGA. Starting from pharmaceutical solvent lists, a new solvent was sought using partial solubility parameters. It had to dissolve PLGA well and form a partial solvent combination with the surrounding water phase.

Next, the system PLGA – solvent – water was characterized within a single nozzle co-flow set-up, consisting of a capillary in a tube. At the top of the capillary, under dripping regime, monodisperse droplets were formed. The effect of surfactant and PLGA-polymer concentration was investigated on droplet formation. These criteria, together with solvent saturation in the surrounding water phase, were also investigated for the solvent extraction speed and resulting microparticle monodispersity.

Finally, the production upscaling was considered by investigating a multi-nozzle system. Monodisperse microparticles were produced in a double nozzle system, being the precursor of a higher order multi-nozzle setting. Two different nozzle structures, T-nozzle and a variant on the co-flow nozzle, were investigated. First, their flow regimes, squeezing, dripping, and jetting were mapped. Next, monodisperse solvent droplets containing PLGA-polymer were produced in the dripping regime. The resulting PLGA microparticles were characterized per nozzle, allowing to conclude if both nozzles produced the same monodisperse microparticles. This work provides insights for potential upscaling of (monodisperse) particle production processes.