Institut für Strömungslehre und Wärmeübertragung

Bachelor or Master Thesis

Drop-jet collisions for cells-loaded alginate fibers

The primary goal of this project is to demonstrate that in-air microfluidics, which has been successfully employed to produce alginate fibers with regular aqueous inclusions [1], can be employed to encapsulate living cells. Cells-loaded fibers are of great interest for biomedical applications such as large-scale cell screening and tissue engineering. The proposed method is highly innovative and relies on the collisions in air of one stream of droplets with one continuous jet, which can form the so-called “drops-in-jet” structure. If the main jet is made of alginic acid, it is possible to solidify this structure “on the fly” by adding a second jet providing cross-linking agents such as calcium cations, see figure 1. The droplets, which are embedded in the alginic acid jet, are typically made of a different liquid containing actives or living cells of interest. Compared to classical chip-based microfluidic approaches, this method is faster, cheaper, less prompt to cross-contamination and does not suffer from clogging risk.

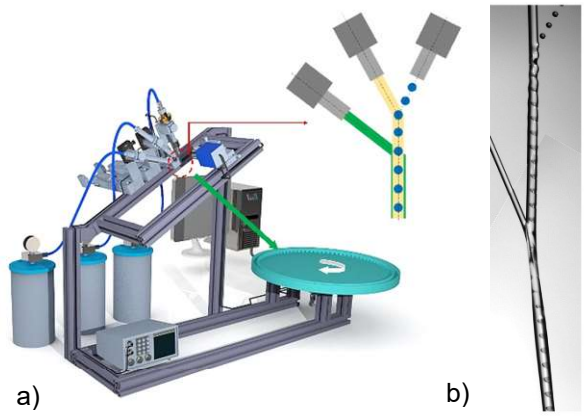

Figure 1: In-air microfluidic for advanced fiber production. a) Sketch of the set-up and desired drops/jets combination. b) Picture showing 200 µm drops (right) colliding with a 300µm jet of alignic acid (center) and getting solidified by a calcium chloride jet (left). c) Resulting fibers showing the regular inclusions originating the embedded droplets. Scale bar 2mm.

To date, it has been possible to suspend and print cells in the form of regular droplets. The quick sol-gel transition has also been successfully achieved while employing ethanol in the calcium chloride jet. Preliminary results show that ethanol removal, without further modification of the formulations, leads to rather wet, irregular and not very robust hydrogel fibers. Thus, the main challenge of this project is to adapt the sol-gel process to improve its compatibility with living cells.

<u>Reference</u>

[1] Marangon, Baumgartner, Planchette, Phys. Rev. Applied **19** (2023), 054006

<u>Tasks</u>

- WP 1: Adapting the jet compositions and/or the set-up (heating) to have cell-compatible environment during the whole process
- WP 2: Cultivating the cells and formulating a bio-ink that can be printed
- WP 3: Combining WPs 1 and 2 to obtain cell loaded fibers. Evaluate the cell viability and if possible cultivate the cells into the fibers

<u>We offer</u>

- A scientific supervision of high quality in an international and dynamic work atmosphere
- The possibility to co-author a peer-reviewed scientific publication or conference contribution
- Access to all the required facilities

The interdisciplinary project will be primarily led by Prof. C. Planchette from the Institute of Fluid Mechanics and Heat Transfer (TUGRAZ) in collaboration with Prof G. Sommer from the Institute of Biomechanics (TUGRAZ) and Prof. B. Rinner from the Core Facility Alternative Biomodels & Preclinical Imaging (Med. Uni). The project can start any time. If interested, please contact Carole Planchette, Tel. 0316 873-7357, Email carole.planchette@tugraz.at