Rapid and cost-effective fabrication of microchromatography integrated with microelectrode impedance sensor

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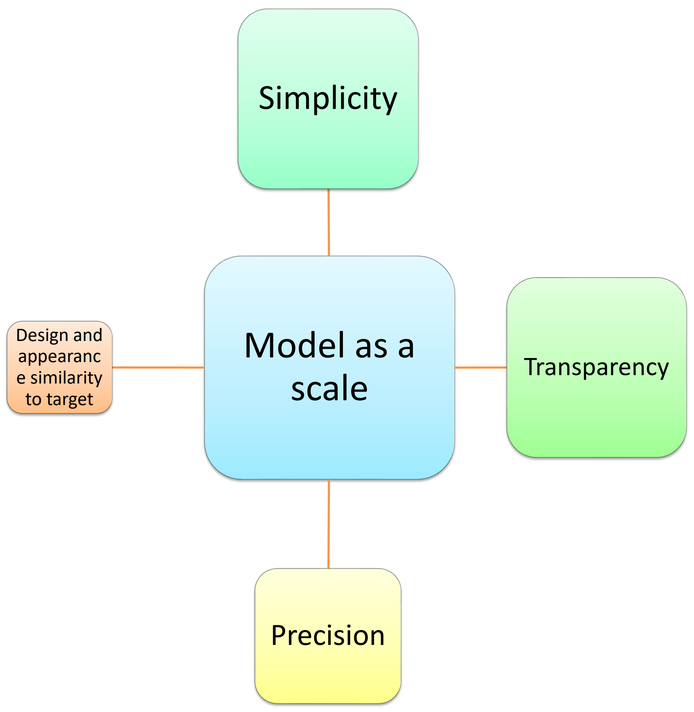
Introduction

Chromatography is considered an indispensable operation unit for purifying therapeutic biomolecules in biopharmaceutical processes [1]. Generally, the common lab-scale and pilot-scale strategies for defining suitable resin and chromatographic operations are tedious and costly [2]. Hence, more economical and rapid bioprocess development and scale-up strategies are in demand in the industry. For this purpose, many research works have been focused on strategies to further scale-down and parallelize experimentations by implementing good representative models such as microfluidic structures integrated with different sensors [3,4].

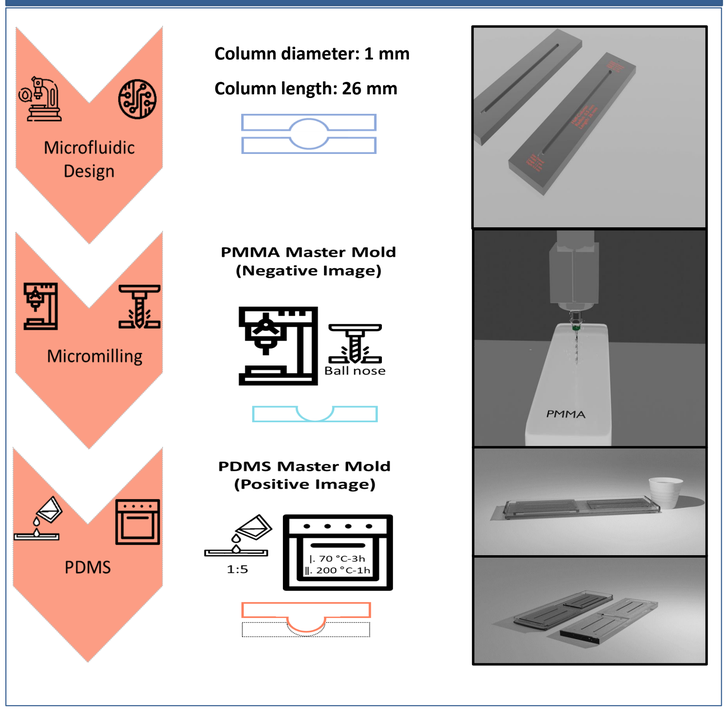
Research Methodology

The potential quality criteria for right scale modeling contain a variety of ingredients such as similarity to target, robustness, precision, simplicity, theoretical tractability, and transparency [5,6]. Not all of these characteristics could be found in a single constructed model, and there is always a need to balance between these features.
The current approach in this project is to construct a miniaturized model with more emphasis on simplicity, as well as fast and cheap production. Since the objective of our microfluidic model is to design and optimize the biopharmaceutical manufacturing process, the precision and robustness of the system should be fit for the purpose of the preparative chromatographic columns.

- **Emphasis of each criterion of the scale-model criteria in our miniaturized system**



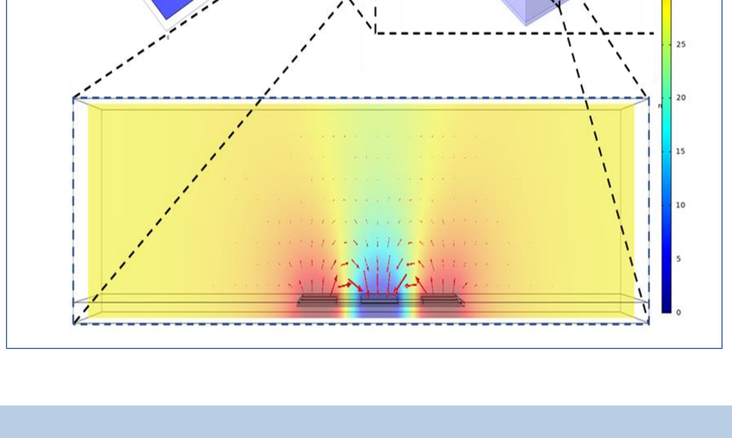
Microcolumn Design & Fabrication



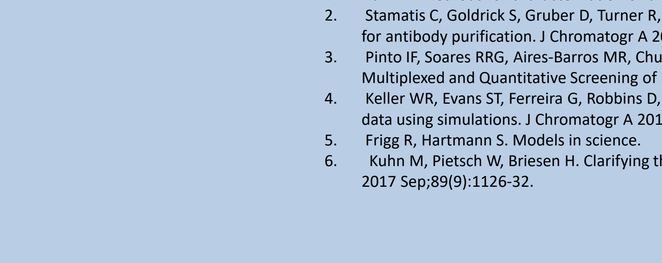
Electrode Design

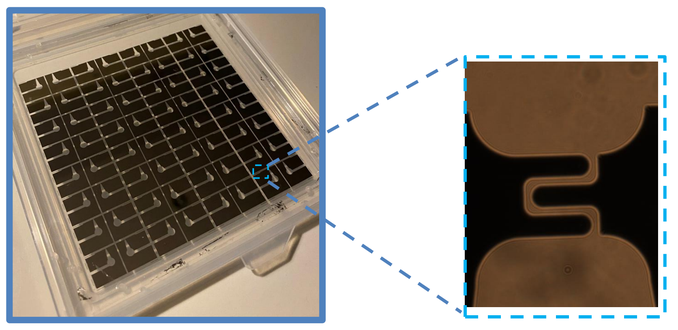
- **Type:** Planar Interdigitated microelectrodes
- **Thickness:** 140 nm
- **Composition:** TiW(90% W- 10% Ti)
- **Measurement range:** 1 mS/cm-400 mS/cm

I. Location and dimensions of interdigitated electrodes



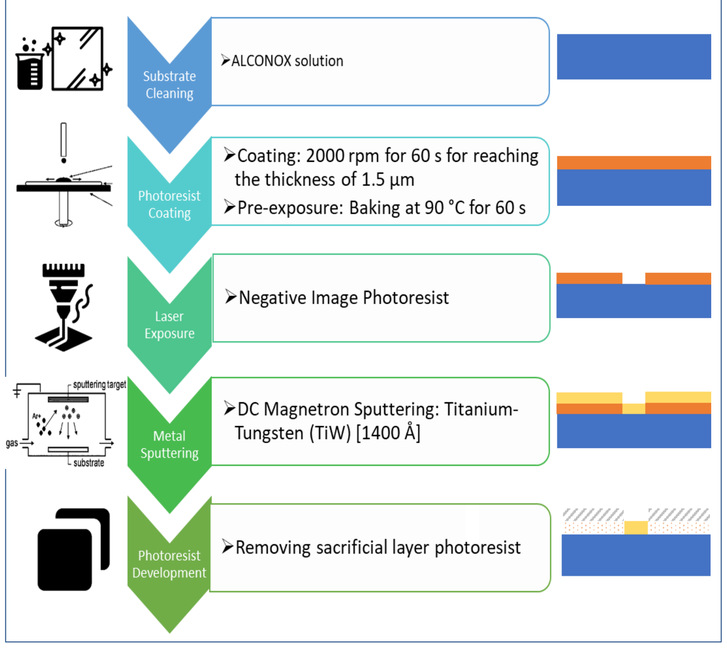
II. CFD studies of current comprisement of interdigitated electrodes in microcolumn outlet-let channel



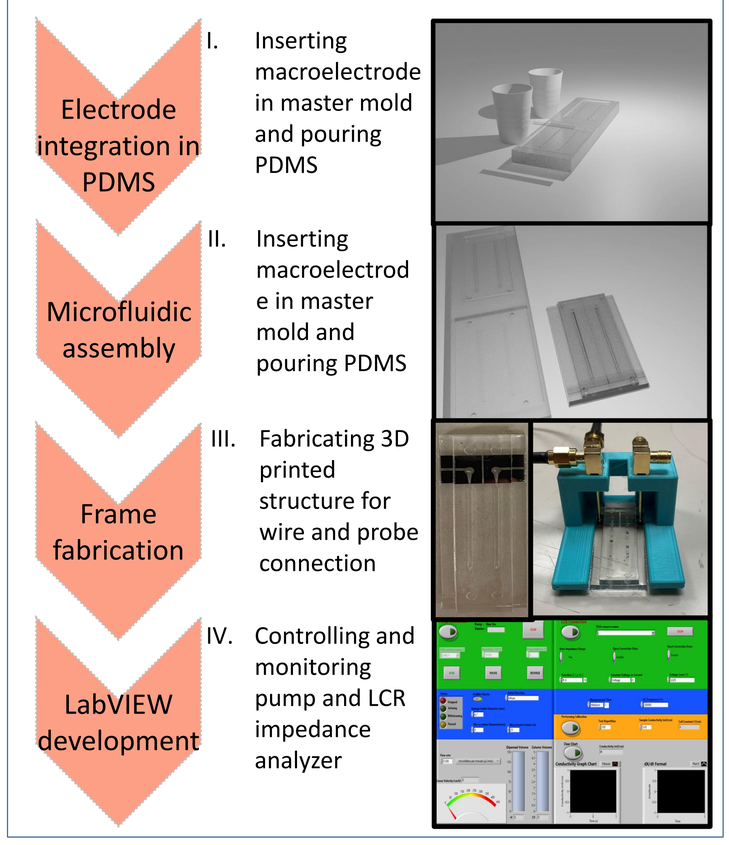


Electrode Microfabrication

Lift-off Process



Microsystem Integration & Software Development



Future Plan

Determinizing chromatographic column efficiency and investigating possibility of protein concentration measurement via impedance sensor

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References

1. Hahn R. Methods for characterization of biochromatography media. J Sep Sci 2012;35:3001–32. https://doi.org/10.1002/jssc.201200770.
2. Stamatis C, Goldrick S, Gruber D, Turner R, Titchener-Hooker NJ, Farid SS. High throughput process development workflow with advanced decision-support for antibody purification. J Chromatogr A 2019;1596:104–16. https://doi.org/10.1016/j.chroma.2019.03.005.
3. Pinto IF, Soares RRG, Aires-Barros MR, Chu V, Conde JP, Azevedo AM. Optimizing the Performance of Chromatographic Separations Using Microfluidics: Multiplexed and Quantitative Screening of Ligands and Target Molecules. Biotechnol J 2019;14:1–11. https://doi.org/10.1002/biot.201800593.
4. Keller WR, Evans ST, Ferreira G, Robbins D, Cramer SM. Understanding operational system differences for transfer of miniaturized chromatography column data using simulations. J Chromatogr A 2017;1515:154–63. https://doi.org/10.1016/j.chroma.2017.07.091.
5. Frigg R, Hartmann S. Models in science.
6. Kuhn M, Pietsch W, Briesen H. Clarifying thoughts about the clarification of liquids–Filtration and the philosophy of science. Chemie Ingenieur Technik. 2017 Sep;89(9):1126-32.