VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Zhuoheng Zhou**

The public defense will take place on **Tuesday 15th October 2024 at 5:00 pm** in room **I.2.03** (Building I, VUB Main Campus)

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ADVANCING MODERN LIQUID CHROMATOGRAPHY THROUGH INSTRUMENT OPTIMIZATION AND COLUMN DESIGN

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Abstract of the PhD research

The key factors that significantly enhance chromatographic efficiency, sample throughput, and detection sensitivity encompass the utilization of ultra-high-pressure and the adoption of low-flow conditions. These achievements would not have been realized without the consideration of instrumentation optimization and the advancement of column technologies, which constitute the two main topics around which the current doctoral thesis is structured.

To ensure the fulfillment of promised resolving power under ultra-high-pressure conditions, the kinetic performance limits have been assessed by considering the impact of instrument fluidic design on system pressure, dispersion, and retention characteristics. The instrument configuration has been optimized for a 1500-bar UHPLC system. A generic UHPLC method development approach is elaborated on the efficacy of column coupling, and the effects of gradient-operating parameters on the overall separation performance.

The advancement in column design involved the fabrication of a polymer-monolithic capillary column for low-flow operation. Synthesis conditions, affecting column morphology and performance robustness, are discussed. Furthermore, its applicability is demonstrated for high-throughput and high-resolution gradient bioanalysis. To bridge the knowledge gap between column morphology and chromatographic processes, tomographic reconstruction and subsequent stereological analysis were performed. Transport phenomena were quantitatively correlated with morphological characteristics.