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 **Sara Abbasi**

The public defense will take place on **Friday 10th October 2025 at 4 pm** in room **D.2.01** (Building D, VUB Main Campus)

To join the digital defense, please click here

PHOTONICS-ENHANCED RAMAN SPECTROSCOPY FOR THE IDENTIFICATION OF HEMOGLOBIN FRACTIONS

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Abstract of the PhD research

Diabetes mellitus affects over 500 million people worldwide, with cases steadily increasing over the years. This chronic condition significantly raises the risk of complications across multiple organs and premature death. Early and accurate diagnosis is crucial to managing diabetes effectively and reducing its long-term impact. Glycated hemoglobin (HbA1c) is widely recognized as the gold standard for evaluating long-term blood glucose control and predicting the risk of complications. However, current Point-of-Care (POC) devices for HbA1c testing, while quick, often lack accuracy and reliability. Additionally, inherited hemoglobin disorders can interfere with HbA1c measurements, leading to misdiagnoses or underestimations of blood glucose levels. This highlights the need for diagnostic tools capable of simultaneously detecting HbA1c levels and identifying hemoglobin variants in a single, efficient test.

This PhD research is part of the EU-funded VortexLC project, which aims to develop a low-cost POC device for accurate HbA1c measurement and comprehensive Hb variant analysis. The approach combines liquid chromatography for separation with optical detection modules, with the detection the main focus of this PhD research. Through benchmarking optical spectroscopy techniques, Raman spectroscopy was identified as a powerful method for distinguishing hemoglobin variants in liquid samples, particularly when enhanced with Surface-Enhanced Raman Spectroscopy (SERS). The identification process was automated using machine learning, which further improved the sensitivity, reliability, and speed of HbA1c testing. To further enhance efficiency, the SERS module was integrated with optical components, including a microlens array, to maximize light collection and improve the SERS signal quality of hemoglobin variants, while meeting the compact and robust design requirements of POC devices.

This research contributes to the development of a sensitive detection module within the VortexLC project, aiming to improve diabetes care, enable timely interventions, and provide insights into hemoglobin biochemistry across diverse patient populations.