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DOCTOR OF ENGINEERING SCIENCES

of **Mehrdad Lotfi Choobbari**

The public defense will take place on **Thursday 31st October 2024 at 4pm** in room **D.2.01** (Building D, VUB Main Campus)

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ILLUMINATING THE INVISIBLE: UNVEILING MICROPLASTICS IN WATER THROUGH ADVANCED OPTICAL TECHNIQUES

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Abstract of the PhD research

Microplastics (MPs) emerged as a potential threat to the environment, especially polluting the water resources. Moreover, reports show the presence of MPs in the air we breathe, in the food we eat, and even in our body. In fact, these tiny MPs are mainly the result of the fragmentation of bigger plastic waste that finally find their ways to our daily life. Although a myriad of methodologies has been proposed so far for the study of MPs, still there is a crucial need to investigate the boundaries of the available analytical techniques applicable to a specific type of MPs in a specific sample. Furthermore, it is of great importance to explore the possibility of devising a portable and low-cost device for online monitoring of MPs, mitigating the challenge of comparing between the reported data on MPs in the literature.

This PhD study aims to comprehensively investigate the potential of Raman spectroscopy and static light scattering (SLS) for the analysis of MPs in drinking water. Raman spectroscopy is a technique whereby one can identify the unique chemical fingerprint of different materials. Thus, we applied this method to identify the chemical composition of different types of MPs in water. In addition, a more advanced mode of this technique, called Raman imaging, is fully utilized to take chemical images of MPs with complex compositions, revealing precise information about their morphological structure.

On the other hand, SLS is a technique whereby one can detect the presence of particles in a volume, similar to a rainbow showing the presence of water droplets in air. As such, we applied SLS to characterize the size and number of MPs in water. To achieve the latter, the combination of SLS with advanced data analysis techniques such as principal component analysis (PCA) and linear discriminant analysis (LDS) was employed as well.

In the final stage of this PhD project, extensive attention is paid to the design and fabrication of a compact and multimodal device for efficient detection of MPs in water using Raman spectroscopy. A glass-based microfluidic chip, coupled with an acoustic actuator, is made to trap and enrich the plastic particles in water using acoustic forces as they pass through a microchannel. Next, optical components such as half-ball lenses and a spherical reflector are designed and integrated with the latter device to improve the optical performance of the system and the sensitivity of detection. It is shown that the developed methodology not only expedites the measurement process from 4 days to 1.5 hours, but also provides a comprehensive analysis of the enriched MPs owing to the increased sensitivity. The achieved results hold great promise for advancing efficient and high-throughput monitoring of MPs in water using Raman spectroscopy.