PLASMONIC UV SENSOR FOR CONTINUOUS MONITORING OF BTEX IN GROUNDWATER

Rachel Gonzalez[1,2], **Julien Mahy**[2], **Benoît Heinrichs** [2], **Sophie Pirard** [1]

[1] Haute Ecole Libre Mosanne (HELMo), Centre de Recherches des Instituts Groupés de HELMo (CRIG), Liège Belgium; [2] University of Liège, Nanomaterials, Catalysis, Electrochemistry (NCE) - Department of Chemical Engineering, Liège Belgium (Rachel Gonzalez: r.gonzalez@uliege.be)

ABSTRACT

Benzene, toluene, ethylbenzene, and xylenes (BTEX) are toxic compounds commonly found as pollutants in water. Analytical methods such as GC-FID are currently used to quantify BTEX in groundwater. Although very sensitive, these methods are expensive, time-consuming, and involve a periodical sampling. Optical fiber sensors based on evanescent wave absorption spectroscopy could be an *in-situ* efficient low-cost alternative.

Optical fibers are made of three layers: (1) an acrylate protective layer, (2) a fluorine-doped silica cladding, and (3) a pure silica core. Light is transmitted in the core along the optical fiber by total internal reflection. However, at the cladding-core interface, evanescent waves propagate in the normal direction and decrease exponentially with the distance beyond the core surface. By removing the cladding, evanescent waves can directly interact with the surrounding medium. If a cladding-free optical fiber is immersed in a medium which contains analytes that absorb light, a decrease of the signal transmitted along the fiber may be detected.

The aim of the present work is to develop an optical fiber sensor based on evanescent wave spectroscopy absorption in the UV wavelengths to measure BTEX in groundwater in real-time. The desired sensitivity is less than 1 ppm. To reach this goal, a polydimethylsiloxane (PDMS) layer is synthesized by sol-gel and deposited on the core surface of the cladding-free optical fibers by a dip-coating process. PDMS has a great affinity with BTEX which are adsorbed on its surface and, thus, concentrated near the core surface. This results in a sensitivity enhancement of the sensor.

Last experiments show promising results as a signal loss was detected for a solution of 1 ppm of ethylbenzene. A first calibration curve has been drafted from 1 to 16 ppm. The literature reports that the use of nanoparticles of silver and/or palladium could further increase the sensitivity of the sensor thanks to the effect of surface plasmonic resonance.

Experiments to corroborate this hypothesis are performed. Indeed, the silica surface of the core of the optical fiber is functionalized with (3-aminopropyl)triethoxysilane (APTES) to improve the grip of the metallic nanoparticles on the sensor surface. Then, the uncladded and functionalized sensor are soaked in a solution containing the nanoparticles and, finally, as previously, the sensitive part of the sensor is coated with PDMS. The nanoparticles synthesised using an eco-friendly route are characterized by TEM, DRX and UV-Vis spectroscopy.