Optical Detection of Glyphosate in Water

R. E. de Góes[*a], G. R. C. Possetti[b,c], M. Muller[a], J. L. Fabris[a]
[a]Federal University of Technol.-PR, 3165 Sete de Setembro Av., Curitiba, Brazil, 80230-901;
[b]Water and Sanitation Company of Paraná State (Sanepar), 151 Eng. Antônio B. Ribas St., Curitiba, Brazil, 82800-130;
[c]Higher Institute of Administration and Economy (ISAE), 2943 Visc. Guarapuava Av., Curitiba, Brazil, 80010-100.

ABSTRACT

This work shows preliminary results of the detection of Glyphosate in water by using optical fiber spectroscopy. A colloid with citrate-caped silver nanoparticles was employed as substrate for the measurements. A cross analysis between optical absorption and inelastic scattering evidenced a controlled aggregation of the sample constituents, leading to the possibility of quantitative detection of the analyte. The estimate limit of detection for Glyphosate in water for the proposed sensing scheme was about 1.7 mg/L.

Keywords: Optical fiber spectroscopy, Raman scattering, optical extinction, silver nanoparticles

1. INTRODUCTION

Glyphosate (N-(phosphonomethyl)glycine) is used in different commercial formulations of herbicides applied worldwide. As an effective broad-spectrum and systemic herbicide, glyphosate is successfully used to control weeds on cultures and gardens. Development of genetically modified crops resistant to herbicides has contributed to the wide use of glyphosate in agriculture[1].

The human health risk has been discussed, considering residuals from the herbicide found in food[2], and also consequences of water contamination. Some works focused on the carcinogenicity of glyphosate[3] whereas others indicate that metal glyphosate compounds accumulated in ground water increase the water hardness and may be the cause of renal disease[4]. Controversies about the toxicity of glyphosate have made meaningless the establishment of a safe limit for glyphosate by international agencies. However, given its widespread use and complexity of conventional analytical detection, there is still a demand for the development of highly sensitive, fast and cost effective methods for its detection. Surface-enhanced Raman spectroscopy (SERS) has emerged as an alternative technique for the detection of contaminants in water[5] and traces of herbicides in food[6,7]. SERS overcomes one of the most important limitations of the interrogation techniques based on Raman scattering: the low intensity of the signal resulting from the small cross section, as well as the low concentration of the molecules under analysis[8]. Two mechanisms, electromagnetic and charge transfer, are responsible by the intensification of the Raman scattering near a metallic nanostructure. Light incident in a metallic nanostructure may produce a coherent oscillation of electrons at the surface producing a Localized Surface Plasmon Resonance (LSPR). When the analyte is close to the nanostructures, the intense electromagnetic fields of the LSPR make possible the SERS. The analyte may also be adsorbed on the surface of the metallic nanoparticle, exchanging charge with this surface and producing an amplification of the vibrational oscillations and Raman scattering. Some authors have proposed SERS methods for the detection of glyphosate with solid substrates[9,10] and colloidal solutions of nanostructures for other substances[11]. Raman spectrum of glyphosate results not only from the interaction with the substrate but also with the used solvent. Consequently, different spectra are obtained with solid and liquid substrates. Using water as solvent, broadened bands resulting from hydrogen bonds are observed, which are dependent on the pH of the solution[12].

In this work, silver nanoparticles produced by laser ablation in a citrate-water solution were used as a substrate for the detection of glyphosate. Citrate proportion and the parameters for the laser ablation were chosen in order to form a stable solution, compatible with the Raman scattering measurement time in the orders of minutes, when glyphosate is added to the colloid in two different concentrations.

*rgoes@utfpr.edu.br; phone +55 41 3310-4760.

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