

Characterization of a photoacoustic system for monitoring ammonia volatilization from encapsulated fertilizers

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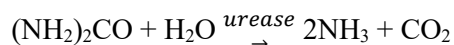
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The growing global demand for food has led to an increased use of synthetic fertilizers. Among them, urea ((NH₂)₂CO) is widely applied as a nitrogen (N) source, an essential element for plant development, due to its high N content and low cost [1].

The enzymatic hydrolysis of urea, catalyzed by urease in the soil, produces ammonia (NH₃) and carbon dioxide (CO₂) according to the equation below. The agronomic efficiency of urea is compromised by N losses through NH₃ volatilization. The release of NH₃ into the atmosphere results in economic losses for farmers, environmental concerns, including aerosol formation, and health problems [2].



To reduce these losses, enhanced-efficiency fertilizers have been developed. One promising approach is the encapsulation of urea with sodium alginate, a biodegradable polymer that enables the gradual release of N into the soil, increasing its availability for plants [3].

Photoacoustic spectroscopy is a sensitive, selective, and rapid technique for detecting trace gases such as NH₃, and is therefore suitable for monitoring emissions in agricultural practices [4,5]. In this context, the aim of this study is to characterize a photoacoustic system for the monitoring of NH₃ emissions from aqueous solutions containing either pure or polymer-encapsulated urea as well as urease, and to assess the efficiency of encapsulation in reducing NH₃ emissions.

The photoacoustic system is based on a distributed feedback quantum cascade laser (DFB-QCL) with a spectral emission matching the characteristic NH₃ absorption peak at 9.5566 μm. Urea microcapsules in sodium alginate were prepared using the emulsification technique [6]. Their N retention performance is evaluated at different temperatures and compared with that of pure urea.

The results demonstrate that the developed system is suitable for NH₃ detection and monitoring. The urea encapsulated with polymer can reduce N losses via NH₃ volatilization. Furthermore, it is expected that rising temperatures lead to an increase in NH₃ losses regardless of the fertilizer composition.

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