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DETECTION OF MALATHION BY THE CO_2-LASER

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Abstract

Possibilities of detecting the vapour of the pesticide malathion by a CO_2-laser, using a photoacoustic technique developed in our laboratory were investigated. A set of vapor photoacoustic spectra of coincidence with this laser were obtained, the samples being: the commercial product available on the market, solvent, emulsifiers, and neat malathion. Relative contributions of the components in the product are discussed.

Introduction

Detecting pesticides and measuring their concentration is a regular concern and objective of analytical chemistry [1]. The usual way would be to take a solid sample (of ground, plant, fruit, etc.) and analyse it by any suitable conventional method - gas/liquid chromatography, or similar. However, a fast and real-time assessment should be done nondestructively, in the field. Atmospheric measurements would be ideal [2]. On the other hand, malathion does not have significant vapour pressures at ordinary temperatures. But, it is never alone in a commercial mixture available on the market. Other components of the mixture have measurable vapour pressures.

We investigated the possibilities of detecting malathion vapor by a CO_2-laser, using a photoacoustic technique developed in our laboratory [3]. The experiments include recording of laser/vapour spectral coincidences in the usual range of CO_2-laser wavelengths, the vapour being: the commercial pesticide product found on the market, neat pesticide (at the commercial purity of the raw component), additives (emulsifiers and the solvent), all with and without air added to a mid-pressure of about 100 mbar.

Results and Discussion

The commercial product found on the market usually consists of neat malathion (at 95% purity), solvent (xylol), and emulsifiers (geronol ff4 and geronol ff6). We found that all the components can give rise to a laser coincidence spectrum, and participate in the spectrum of the product. The spectra of the commercial product and of each of the components are presented in Fig. 1. Since the formulation of the product cannot be published, the discussion is restricted here to quantitative considerations.

It can be assessed that the main contributions to the spectrum of the commercial product come from the emulsifiers and from neat malathion component. This is because of the following. The coincidences of the product are substantially higher at the 9μ band of the laser, whereas xylol does not show such a pronounced difference between the two CO_2-laser bands. Hence, it apparently does not contribute significantly to the

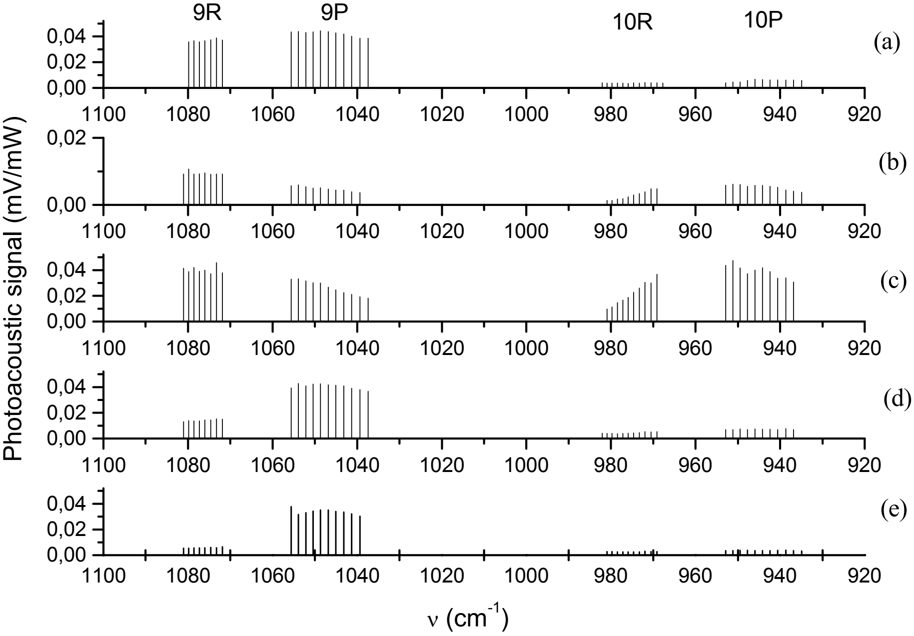

Fig. 1. Laser coincidence spectra of (a) 14.4 mbar commercial malathion product + air to 101 mbar, (b) 3 mbar neat malathion + air to 91.6 mbar, (c) 12.7 mbar xylol + air to 103 mbar, (d) 4.64 mbar geronol ff4 + air to 98.6 mbar, (e) 4.6 mbar geronol ff6 + air to 104 mbar.

spectrum of the product. In the 9μ region, both branches of the laser band are absorbed to a similar extent. This is probably due to the combined contributions of the emulsifiers and malathion. The emulsifiers absorb more in the 9P branch and malathion in the 9R branch.

Overall, the spectrum of the commercial product has fingerprinting potential in the fact that 9 μm laser transition gives rise to significantly stronger coincidences than the 10 μm one.

The question remains, however, how does malathion show measurable vapour pressure and, consequently, a measurable spectrum, if it nominally has a vapour pressure of only 0.5×10^{-9} bar at 30 °C? We suspect the vapour pressure is created by the impurities present in the malathion component of technical purity. This purity is declared at 95%, which leaves 5% for the impurities, consisting mainly of isomalathion, malaoxon, and analogues of trimethylphosphate. It is possible that some of these impurities gives rise to the actual spectrum measured. That can be a subject of further investigations, but is irelevant to the present practical consideration.

Conclusion

Possibilities of detecting the vapor of the pesticide malathion by a CO_2-laser, using the photoacoustic technique developed in our laboratory were investigated. A set of vapor photoacoustic spectra of coincidence with this laser showed that most significant contributions to the spectrum of the commercially available product come from the emulsifiers used in the commercial mixture and neat malathion of the available purity of 95%. The fact that measurable vapor pressure (several mbar) was obtained from the neat substance and that nominally malathion does not posess it, points to a conclusion that it comes from the impurities, i.e. 5% of the contents of the neat substance. Whatever the source of the spectrum, it is measurable by the photoacoustic laser technique, and shows some fingerprinting potential in the pronounced difference between the two laser transitions, such that the 9 μm transition has significantly stronger coincidences.

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