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Name	Ikuo　Ueta		

Advisor	Yoshihiro Saito Yukio Hirata

Title	Miniaturized Sample Preparation Needle for Gas Chromatographic Analysis of Volatile Organic Compounds

(800 words)

In this thesis, the development of novel in-needle sample preparation device for the analysis of gaseous volatile organic compounds (VOCs) in gas chromatography is described. Needle-type sample preparation device has several advantages such as high extraction capacity, simple extraction/desorption process and the feature of repeatable use for more than 100 times.

In Chapter 1, general introduction of this thesis including the aims and scope of the study is described along with the background of this work.

Chapter 2 deals with the development of novel fiber-packed sample preparation needle for the determination of volatile aldehydes and ketones. Simultaneous derivatization/ preconcentration was made during the sampling process of gaseous sample via the derivatization reaction of these carbonyl compounds with 2,4-dinitrophenylhydrazine.

Another derivatization reaction is described in Chapter 3, where ethylene oxide (EO) is successfully derivatized with hydrogen bromide in the extraction needle, and the method is applied to the analysis of EO from real complex samples.

Chapter 4 gives the development of novel particle-packed sample preparation needle for the extraction of gaseous VOCs commonly found in in-house environment. As the extraction medium, a copolymer of methacrylic acid and ethylene glycol dimethacrylate was packed into a section of specially-prepared needle. After the optimization of basic extraction/desorption conditions, the extraction performance including repeatability, recovery and storage performance was studied.

Chapter 5 describes a miniaturized needle extraction device for the rapid and simple analysis of smoking-related compounds in environmental tobacco smoke and smokers' hair samples. The particle-packed needle was employed for the analysis of typical VOCs in tobacco smoke, and formaldehyde and acetaldehyde in smokers' breath were derivatized with fiber-packed needle device. Smokers' hair samples were also packed into the needle, allowing the direct extraction of nicotine from the hair sample.

With the miniaturized sample preparation device, typical smoking-related VOCs were also analyzed to evaluate the potential risk of third-hand smoking in Chapter 6. For the evaluation of this new cigarette hazard, a variety of fabrics were exposed to sidestream smoke, and smoking-related VOCs desorbed form the fabric samples to environmental air was extracted with the particle-packed needle. Smoking-related VOCs in smokers' breath were also measured, and the effect of the breath VOCs on the third-hand smoking pollution was evaluated. The method was further applied to the determination of the actual third-hand smoking pollution in an automobile, and the validity of the method was confirmed.

Chapter 7 contains a new approach to the determination of human breath acetone with particle-packed extraction needle. Breath samples of type-2 diabetic patients and healthy persons were extracted with the needle-type sample preparation device, and the breath acetone concentration was successfully determined. Additionally, the time variations of the breath and urine acetone level of healthy individuals under fasting conditions were monitored.

Finally, the over-all conclusion of this thesis is summarized in Chapter 8.