Liquid chromatography with a gaseous stationary phase

Keisuke Nakamura, Masami Shibukawa\*

*Graduate School of science and Engineering, Saitama University, 255 Shimo-Okubo,*

*Sakura-ku, Saitama 338-8570, Japan, Email:* [*s12mc216@mail.saitama-u.ac.jp*](mailto:s12mc216@mail.saitama-u.ac.jp)

It has been known that liquid water is forced out of the hydrophobic pores when the pressure on reversed-phase liquid chromatographic columns filled with water is released. This phenomenon is a natural consequence of the existence of capillary pressure in the pores of hydrophobic materials unwetted with water and the remaining pore space is occupied by the gas phase of water. This suggests that the gaseous phase thus created in the pores of the packing materials can act as the stationary phase, leading to establishment of a liquid-gas chromatographic system. Liquid-gas chromatography is expected to have several favorable resolution characteristics for volatile compounds.1 Since diffusion coefficients in gas phase are about 104 times larger than those in liquid phase, liquid-gas chromatography would have high resolution and high-speed separation characteristics. Moreover, separation selectivity in liquid-gas chromatography can be controlled by regulation of back pressure applied to the column because the volume of the compressible gaseous stationary phase varies with the applied pressure.

We have examined the retention behavior of various organic compounds on some alkyl bonded silica columns containing the gas phase. Retention factors for most of the organic compounds on the column containing the stationary gas phase are much smaller than those obtained on the column filled with water. In contrast, highly volatile compounds such as alkyl halides show rather strong retention even on the columns containing the gas phase. The fact that the formation of the gas phase in a column causes drastic retention losses for many compounds indicate that, in aqueous system, it is not the alkyl bonded layer but the interface between the bonded layer and water or the interfacial water formed on the hydrophobic surface that has key role in retention. We have recently clarified that there exists interfacial water functioning as the stationary phase in the pores of hydrophobic particles.2 These results indicate that the gas-liquid hybrid stationary phase consisting of the gas phase and the interfacial water has a great potential as a new separation medium for manipulation of retention and separation selectivity in liquid chromatography. In this paper, we will demonstrate selective separation of volatile compounds obtained by liquid chromatography with the gas-liquid hybrid stationary phase. The efficiency of the gas-liquid hybrid separation system will also be discussed.

***Keywords: 3-5 words,*** HPLC, gaseous stationary phase, interfacial water

***Reference:*** (1) J. C. Giddings, M. N. Myers, *J. High Resolut. Chromatogr.*, **6**, 381-382 (1983). (2) M. Shibukawa, Y. Kondo, Y. Ogiyama, K. Osuga, S. Saito, *Phys. Chem. Chem. Phys.,* **13**, 15925-15935 (2011).