

## 【5RF-1701】

### Development of Control System Based on Effective Concentration and Smart Device Detection for Water Preservation

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#### [Introduction]

Environmental assessment of heavy metals has been conducted by instrumental analyses such as ICP-AES. Such analyses require extensive preparations as well as skilled analytical procedures. Moreover, transporting such analytical equipment for on-site measurement is difficult. Although visual colorimetric analysis is used for on-site measurement, it is problematic with regard to identifying concentrations. On the basis of these circumstances, homogeneous liquid-liquid extraction (HoLLE) and a smart device were combined to analyze heavy metals quickly and accurately on the spot (Fig. 1). HoLLE could separate and concentrate heavy metals effectively in several minutes with only reagents added. Smart devices such as smartphones were found able to detect color change via the camera segment easily in several seconds.

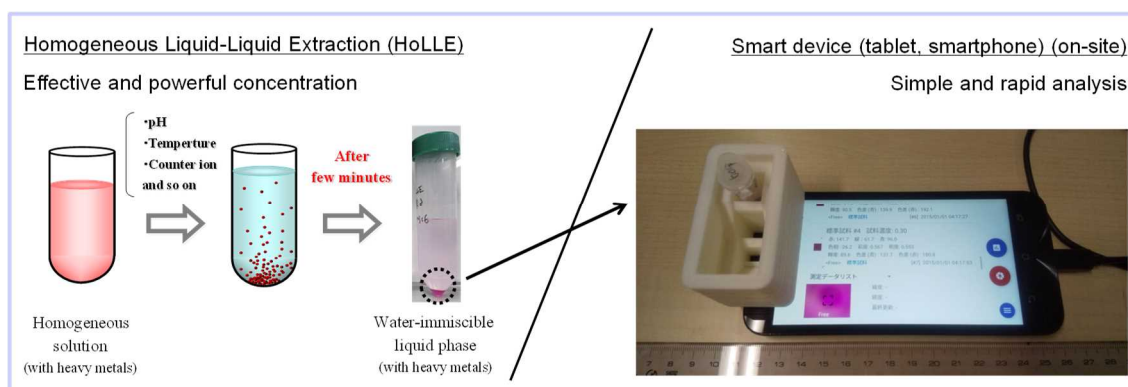


Fig. 1 Developed on-site control system.

#### [Heavy Metal Analysis at ppb Level Based on This System]

Colorimetric analysis with diphenylcarbazide has been used as a simple method to determine hexavalent chromium (Cr(VI)). The low sensitivity of this technique, however, makes it difficult to determine concentrations close to the Japanese water quality standard ( $0.02 \text{ mgL}^{-1}$ ). The Cr(VI)-diphenylcarbazide complex was satisfactorily extracted by HoLLE under a water-2-propanol-dimethyl phthalate ternary solvent system. Under optimal conditions, 88% of the Cr(VI) was extracted into the water-immiscible liquid phase (0.230 mL). In this study, the color analysis measurement performance by a smart device was evaluated. Based on extraction of the hexavalent chromium complex, the determination limit was found to be  $0.0021 \text{ mgL}^{-1}$  ( $0.0021 \text{ ppm}$ : 2.10 ppb) according to the smart device analysis. This value was 10 times more sensitive than the Japanese water quality standard ( $0.02 \text{ mgL}^{-1}$ ). Furthermore, we determined the presence of Cr(VI) in tap water containing a known added amount of Cr(VI) (Table 1). By comparison with conventional absorption spectrophotometry, a good recovery rate in all samples was obtained with this system adopting a smart device. This system was equally applicable to other heavy metals such as lead and cadmium at the ppb level.

**Table 1** Practicality evaluation of this system adopting a smart device.

Cr(VI) added / ppm	(upper) spectrophotometer / (lower) smart device		
	Cr(VI) found / ppm	%RSD (n=5)	Recovery / %
0.02	0.019	1.20	<b>97</b>
	0.020	2.99	<b>100</b>
0.01	0.010	1.17	<b>100</b>
	0.011	6.18	<b>109</b>

※ sample: tap water (National Institute of Technology, Toyama College)

#### [Conclusions]

We developed an on-site quantitative analysis system that combines homogeneous liquid-liquid extraction (HoLLE) enabling powerful concentration just by addition of solution, and smart-device analysis for evaluating concentration from color information and intensity of heavy metal complexes. Trace amounts of heavy metals (ppb level) could be determined using this system, which is expected to have a wide range of applications such as on-site monitoring technology.

#### References

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