軸方向測光液体電極プラズマによる重金属の検出

Detection of Heavy Metals via Liquid Electrode Plasma at the Axial Direction

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1. Introduction: Precise quantification of heavy metals is crucial to better control the pollutants and ensure the quality of human life. Nevertheless, the conventional spectroscopic methods such as inductively coupled plasma atomic emission spectrometry (ICP-AES) are mostly expensive, time consuming, and require professional operators, which increase the difficulty for the in-situ or real-time measurements.

One of the solution to address the problems is by liquid electrode plasma atomic emission spectroscopy (LEP-AES) proposed by our group.[1] LEP-AES is a microfluidic device with a narrow-center part where the liquid sample flows through continuously and the plasma is formed in the narrow channel when high-voltage DC pulse power is applied (Fig. 1A). The advantages of LEP include no requirement of gas, low cost, and less maintenance compared to conventional ICP-AES. Previous study on LEP revealed the spatial distribution of atomic emission along the narrow-center part.[2] Conventionally, the emission spectra were recorded in radial direction at the center of narrow channel and thus the sensitivity was influenced due to the spatial distribution.

In this study, a new LEP microchannel was proposed for the observation from the axial-direction of plasma to prevent the spatial distribution problem and enhance the sensitivity.

2. Experimental: The channel pattern was fabricated on wafer by a photolithography process with SU8-100 photo resistant. Poly(dimethyl siloxane) (PDMS) was pour onto the wafer with designed channel pattern (1×5×0.14 mm^3), followed by curing at 70 ˚C for 1 hr. A 2×2×0.1 mm^3 quartz chip with a pinhole (ϕ = 0.13 mm) in the center was purchased from company. Two PDMS with channel pattern were assembled with the quartz chip in the middle to form a sandwich-like microfluidic (Fig. 1B). Pb standard solution was prepared by diluting 1000 mg/mL ICP standard to desired concentration with 0.1 M HNO_3. The applied voltage, pulse on/off time, and number of pulses were 1400 V, 3 ms/2 ms, 100 pulses, respectively.

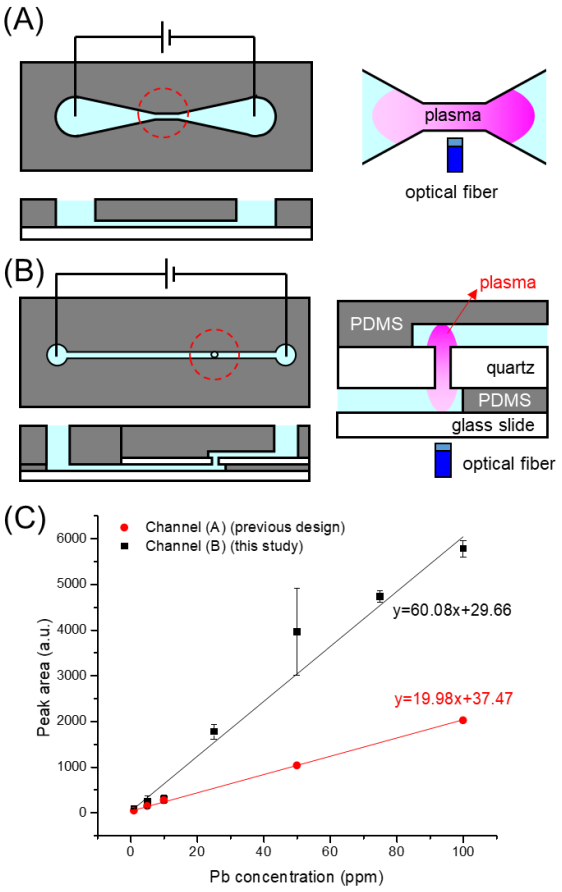

Fig. 1 (A) the conventional LEP design, (B) LEP channel for the observation from axial-direction, and (C) comparison of the emission peak area with different concentration of Pb.

3. Results and Discussion: The preliminary results showed that the proposed microchannel can be applied for LEP-AES measurements. The emission intensity increases proportional to Pb concentration. Moreover, the sensitivity is significantly improved about 3 times by the proposed new design, as shown in Fig. 1C. The characterization and diagnostics of the plasma will be carried out to explain such difference.

Referance

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