Determination of Zinc at a 3-D Printed Carbon Electrode Using a Carbon Pseudo-Reference Electrode

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Introduction

Previous studies have shown the possibility of 3-D printing carbon electrodes. However, these studies required further fabrication steps. In this present investigation we show for the first time the possibility of utilising fully 3-D printed carbon nanofiber–graphite–polystyrene electrodes (figure 1) for the trace determination of Zn^{2+} by differential pulse anodic stripping voltammetry (DPASV).

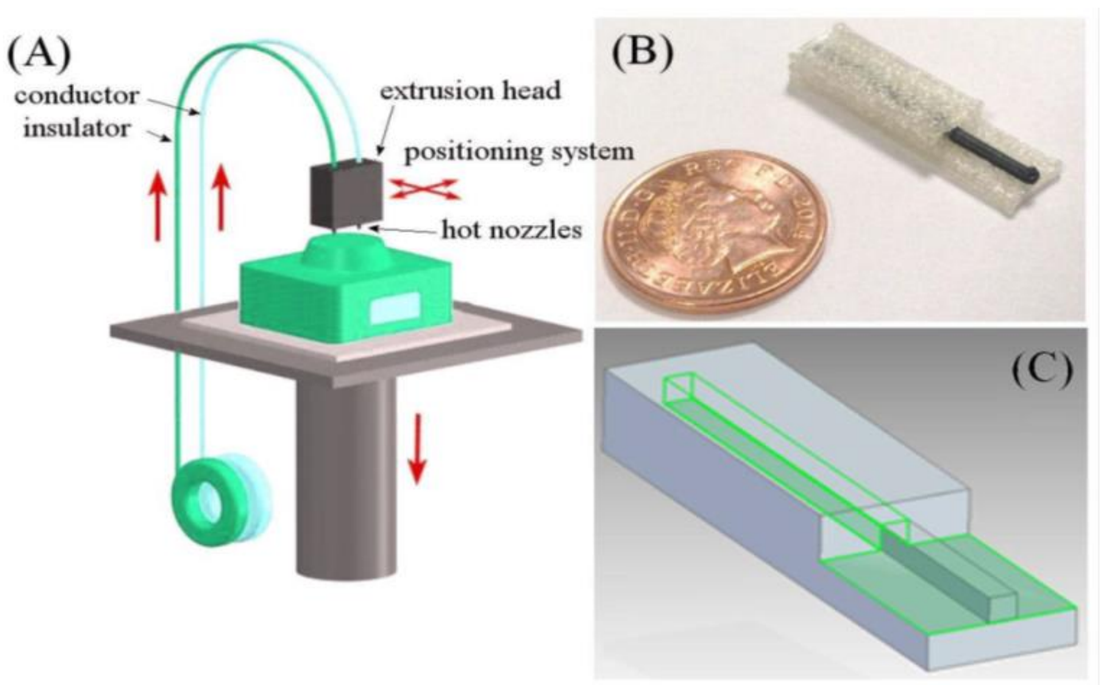

Figure 1. (A) Schematic diagram of 3D printing set up with two feeds (polystyrene insulator and polystyrene composite conductor) (B) Printed electrode. (C) Electrode designed in CAD [1].

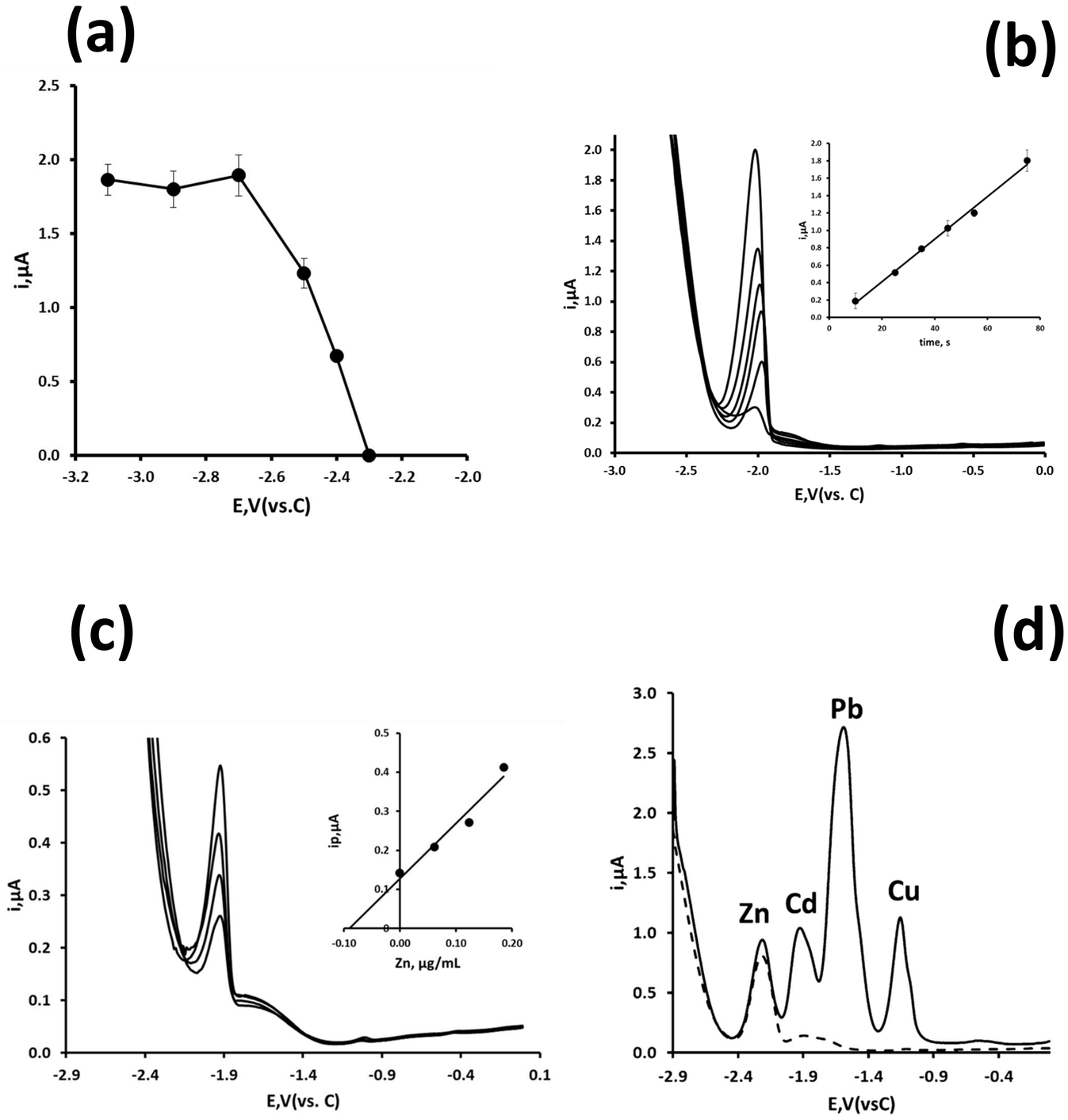

Figure 2. (a) effect of deposition potential for a 0.1 mM Zn^{2+} in 0.1 M acetic acid; (b) Effect of accumulation time on the magnitude of stripping peak current for 773.5 µg/L Zn^{2+}. Error bars represent ±σ. (c) DPASVs for tap water sample. Each addition = 61.8 µg/L Zn^{2+} (d) effect of other metals on the determination of Zn.

Results and Discussion

The determination of trace concentrations of Zn^{2+} by DPASV was then investigated. The effect of accumulation potential (figure 2a) and time (figure 2b) were optimised and found to be -2.9 V (*vs.* C) and 75 s respectively.

A single anodic stripping peak was recorded (figure 2c) with an Ep = -1.9 V (*vs.* C), a linear response from 12.7 µg/L to 450 µg/L with a theoretical detection limit (3σ) of 8.6 µg/L was obtained. Investigations of a tap water sample showed that the method holds promise for the determination of Zn^{2+} in such samples [2].

Conclusions

- The possibility of a fully 3-D printing printed carbon nanofiber–graphite–polystyrene electrodes has been shown.
- DPASV of Zn^{2+} showed stripping peaks, unaffected by other common heavy metals.
- Conditions were optimised of the determination of Zn^{2+} in tap water samples.

References

[1] Z. Rymansaib, *et al.*, *Electroanalysis*, 2016, 28, 1517–1523.

[2] K.C. Honeychurch *et al., Sens. Actuators B Chem.* 2018, 267, 476–482.