Voltammetric Behaviour of Zinc at a 3-D Printed Carbon Nanofiber–Graphite–Polystyrene Electrode and Its Anodic Stripping Voltammetric Determination in Water

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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).

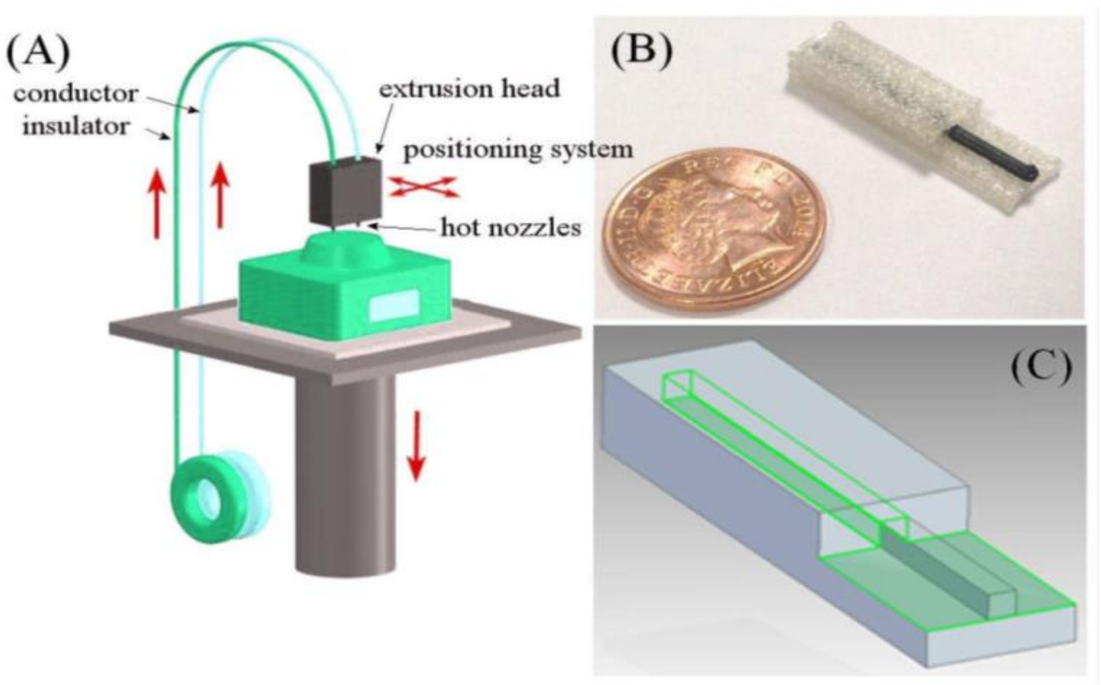

Figure 1. (A) Schematic diagram of 3D printing set up with two feeds (polystyrene insulator and polystyrene composite conductor) (B) Printed electrode. (C) Electrode designed in CAD [1].

Results and Discussion

The determination of trace concentrations of Zn^{2+} by differential pulse stripping voltammetry (DPASV) was then investigated. The effect of accumulation potential (figure 2a) and time (figure 2b) were optimised and found to be -2.8 V (*vs.* C) and 150 s respectively.

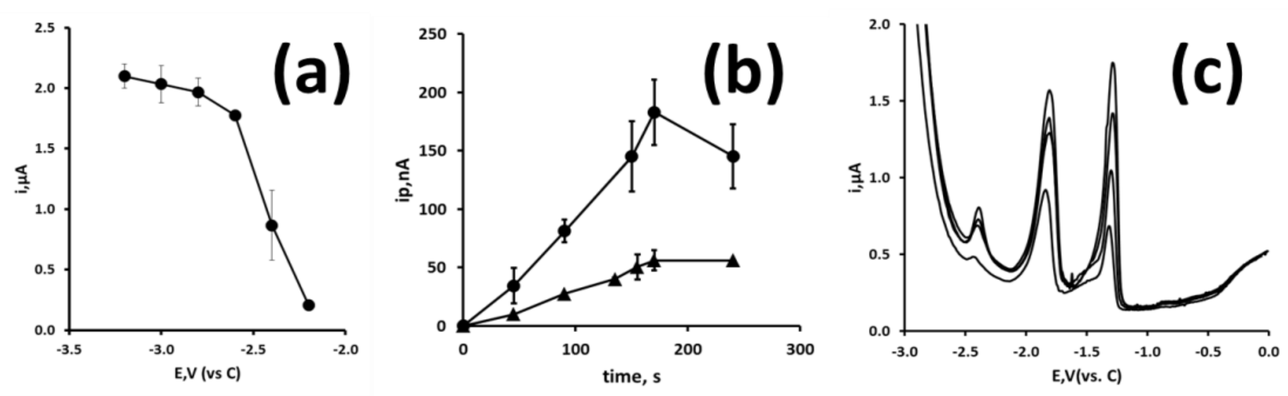

Figure 2. (a) effect of deposition potential for a 0.1 mM Zn^{2+} in 0.1 M acetic acid; (b) Effect of accumulation time on the magnitude of stripping peak current for 36.5 µg/L Zn^{2+}. Error bars represent ±σ. (c) DPASVs for brine water sample. Each addition = 14.6 µg/L Zn^{2+}.

Three anodic stripping peaks were recorded resulting from the surface characteristics of the electrode (figure 2c). Using the monolayer stripping peak, Ep = -1.3 V (*vs*. C), a linear response from 10 µg/L to 55 µg/L with a theoretical detection limit (3σ) of 4.5 µg/L was obtained. Investigations of a brine water sample showed that the method holds promise for the determination of Zn^{2+} in such samples.

Conclusions

- The possibility of a fully 3-D printing printed carbon nanofiber–graphite–polystyrene electrodes has been shown.
- DPASV of Zn^{2+} showed the presence of mono and multi-layer stripping peaks.
- Conditions were optimised of the determination of Zn^{2+} in an environmental water sample.

Reference

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