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Antimony tin oxide – Prussian blue screen-printed electrodes for electrochemical sensing of potassium ions

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Objectives

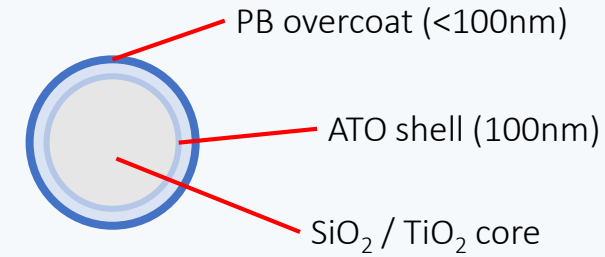
- Development of screen-printed electrodes (SPEs) based on antimony tin oxide nanoparticles (ATO) – Prussian blue (PB) composite materials.
- Electrochemical characterization of ATO-PB-SPEs.
- Analytical applications towards the detection of caffeic acid and potassium ions.

Experimental section

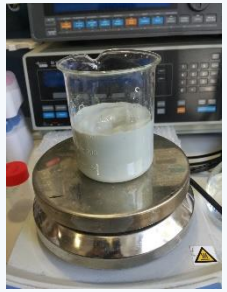
- Cyclic voltammetry (CV), chronoamperometry (CA), electrochemical impedance spectroscopy (EIS) techniques have been applied in the investigation of the electrochemical properties of the ATO-PB materials.
- Influence of pH and potassium ions on ATO-PB electrochemical behavior was investigated by means of CV and EIS techniques.

Results: A Prussian Blue electrochromic paste

Different paste formulations were explored and tested



ø = 3 µm

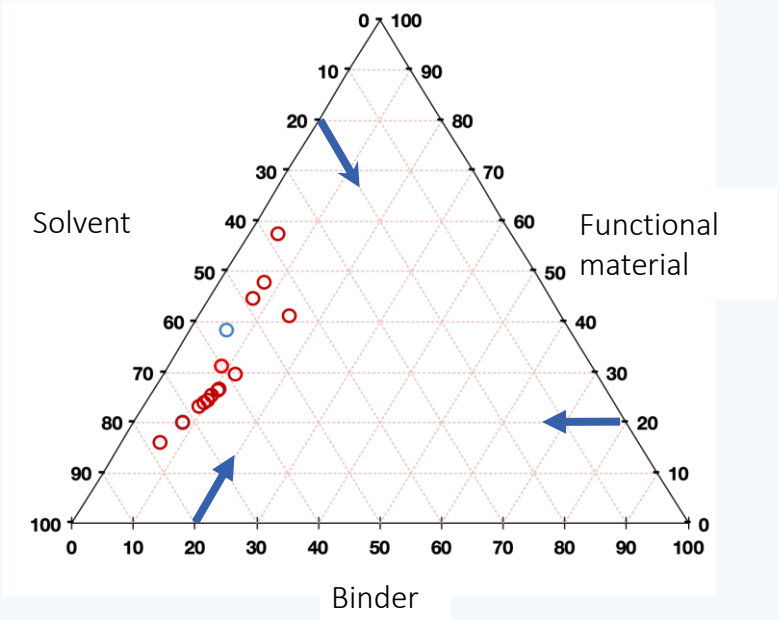


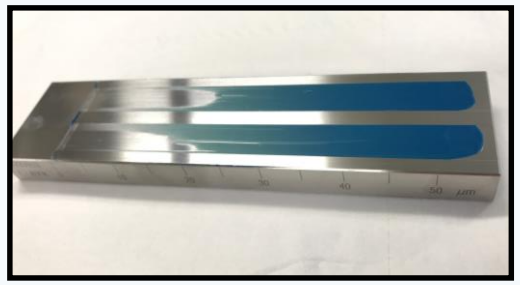
PB-based pigments

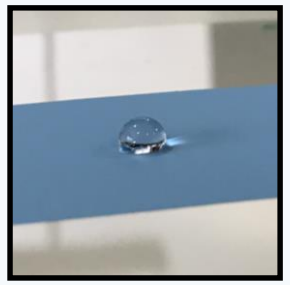
Homogeneity/grain size

Contact angle.

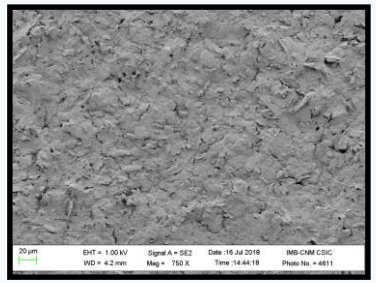
SEC



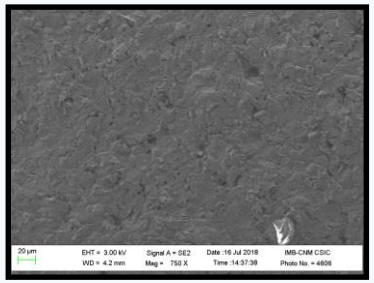




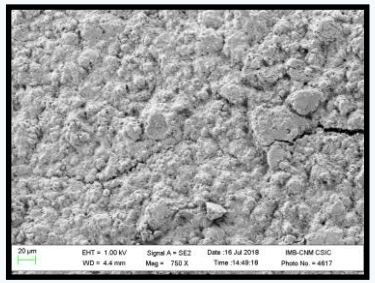
SEM



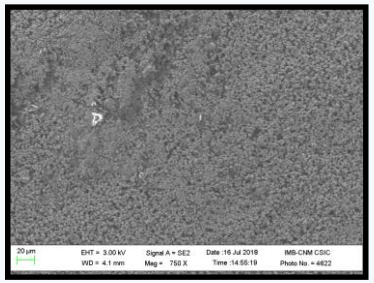
DropSens PB-C



Gwent Ltd. PB-C



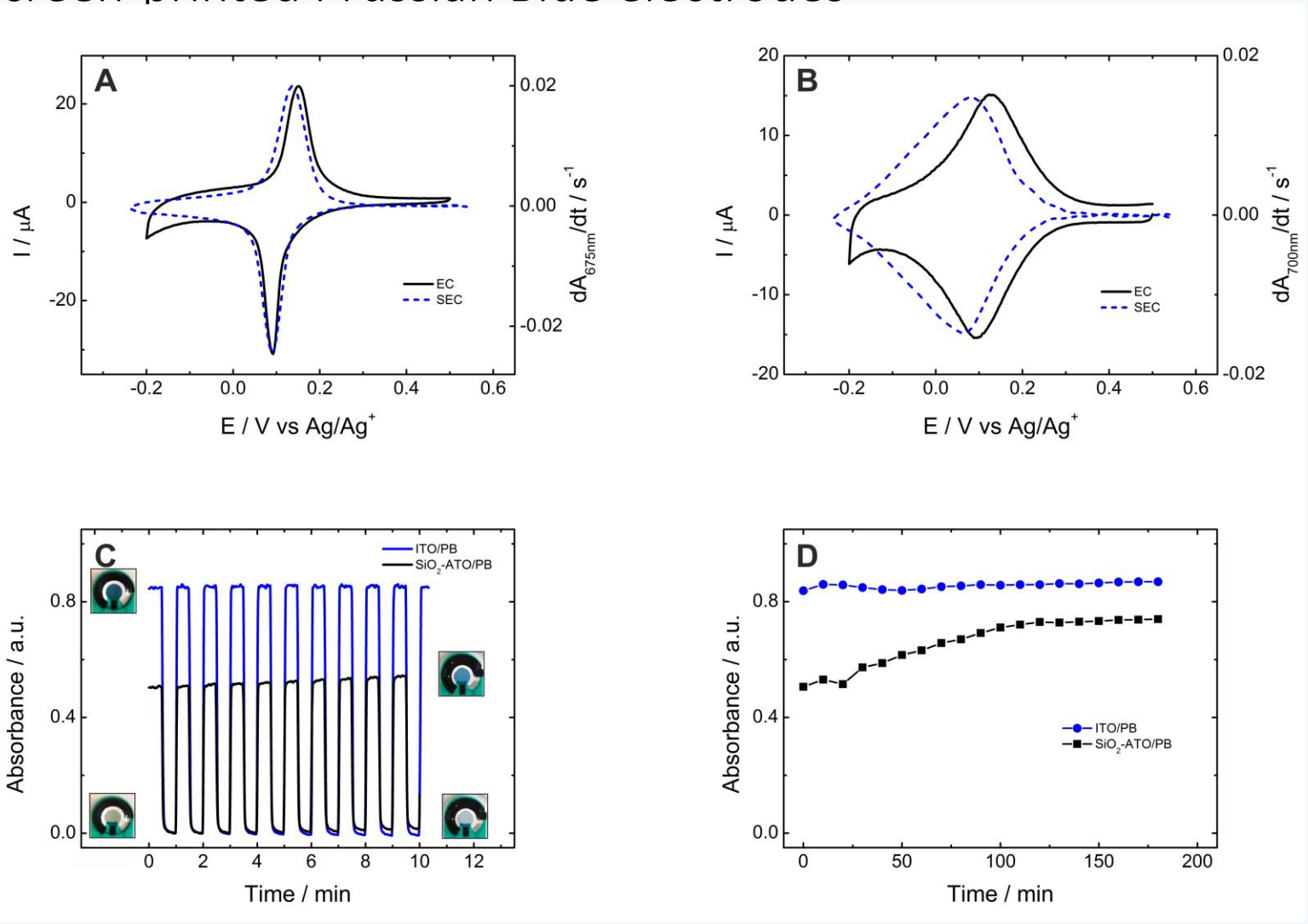
PB-ITO



SiO_2/ATO-PB

Results: Making blue electrodes

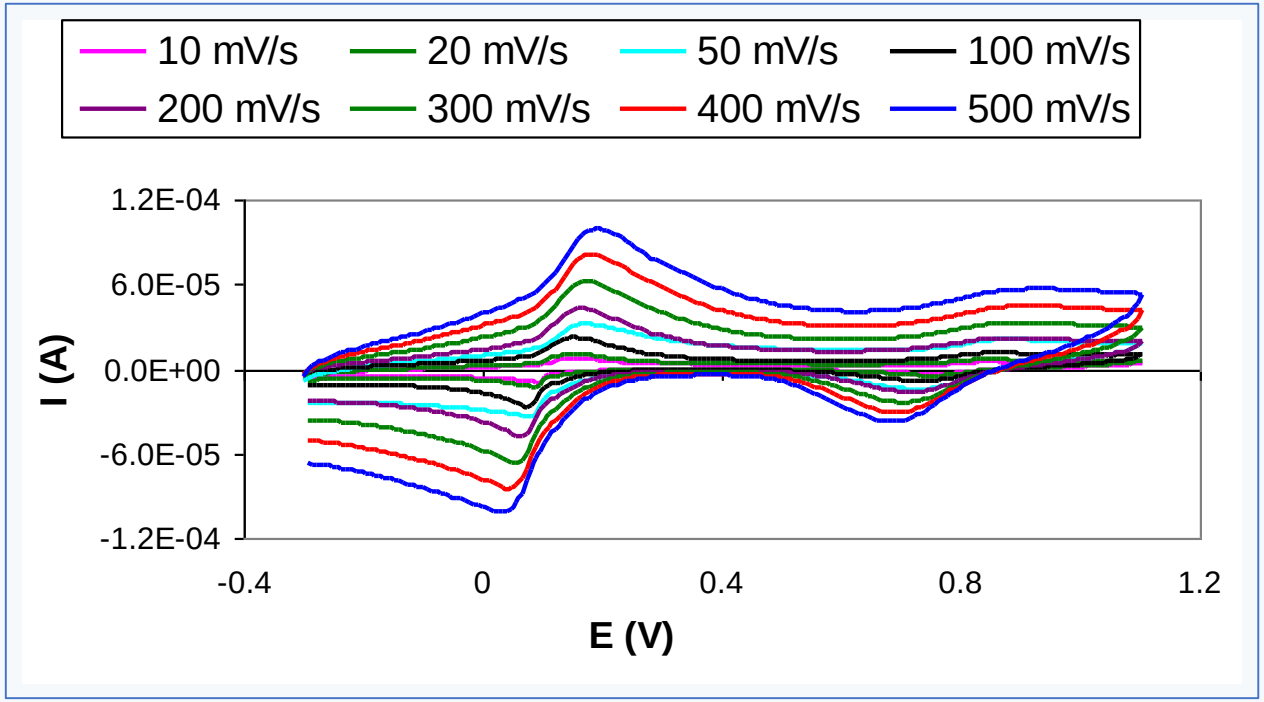
Spectroelectrochemistry of Screen-printed Prussian Blue electrodes

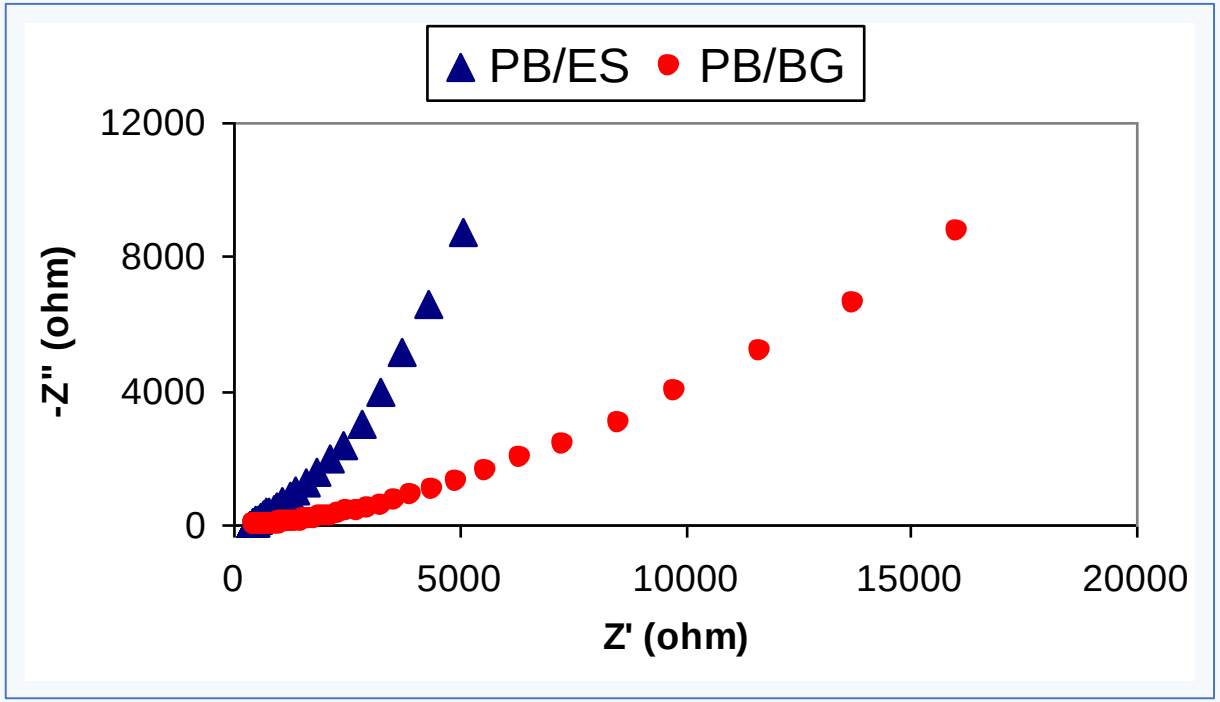


Sensors and Actuators B: Chemical, vol. 290, pp. 591–597, 2019.

Results: Electrochemical characterization

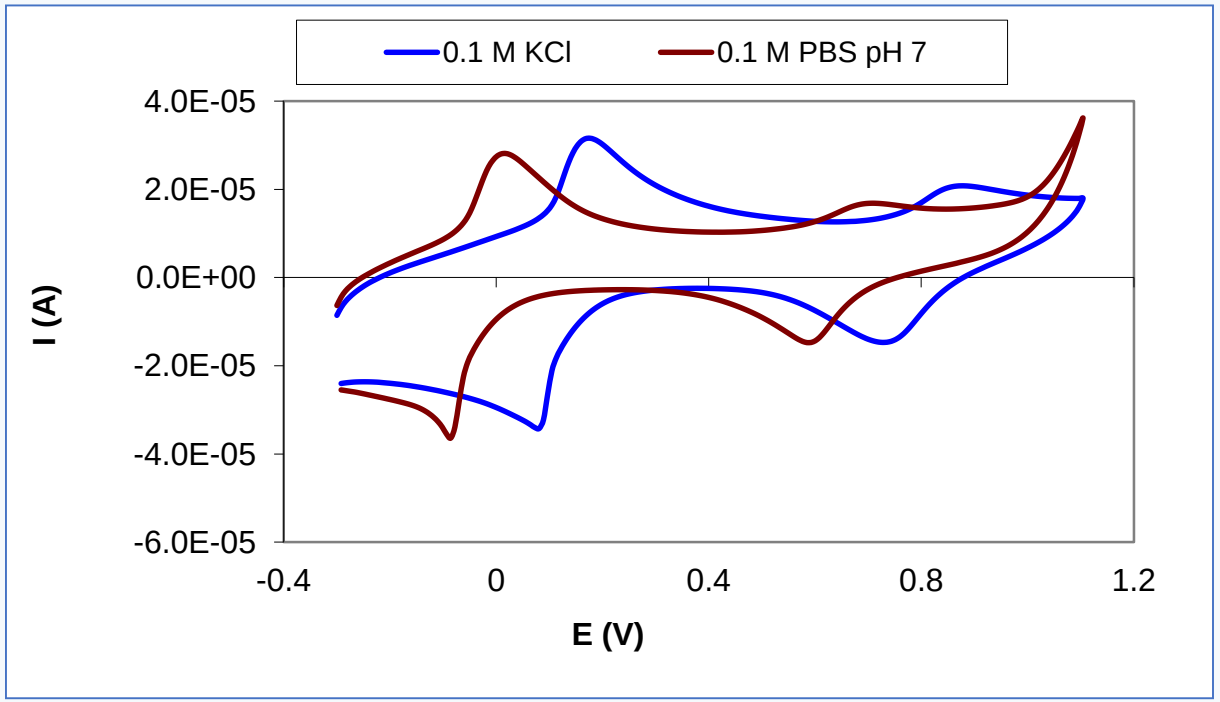
- The ATO-PB sensing material displays electrochemical redox behavior.
- Linear increase of anodic and cathodic peak currents of both PB/ES and PB/BG redox systems with the potential scan rate.
- Higher impedance of the PB/BG redox system.

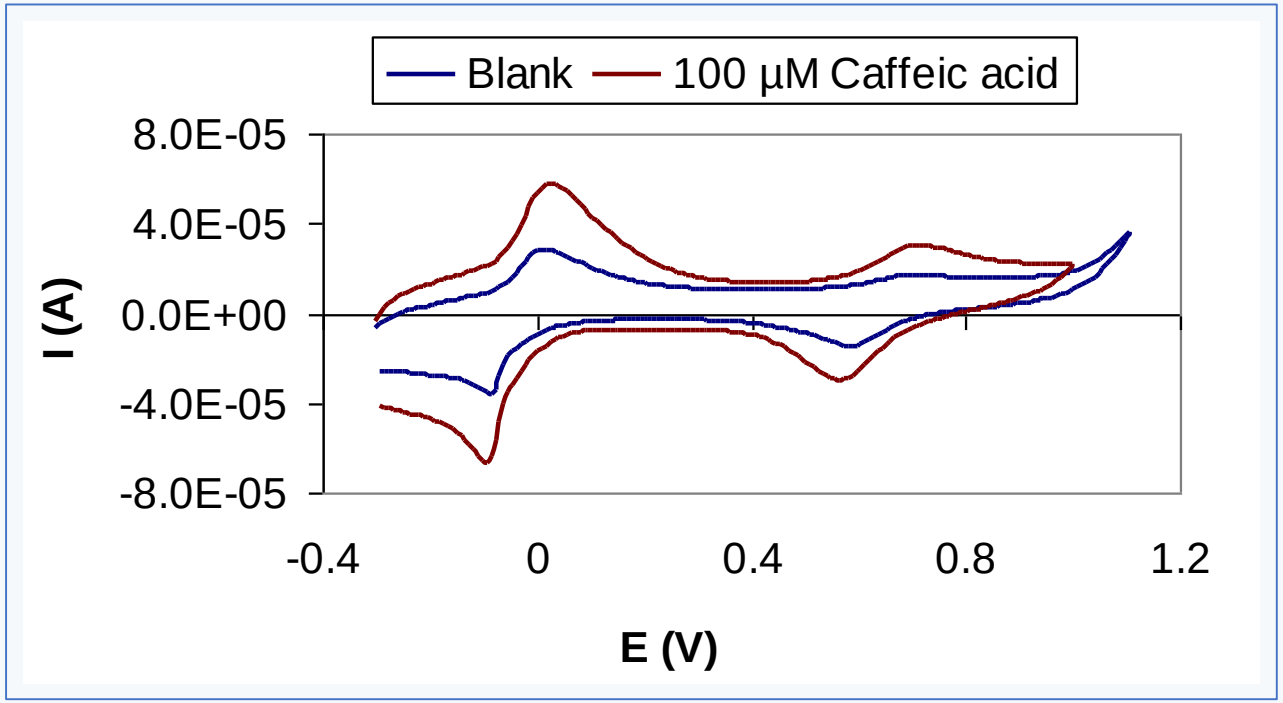




Results: Electrochemical characterization

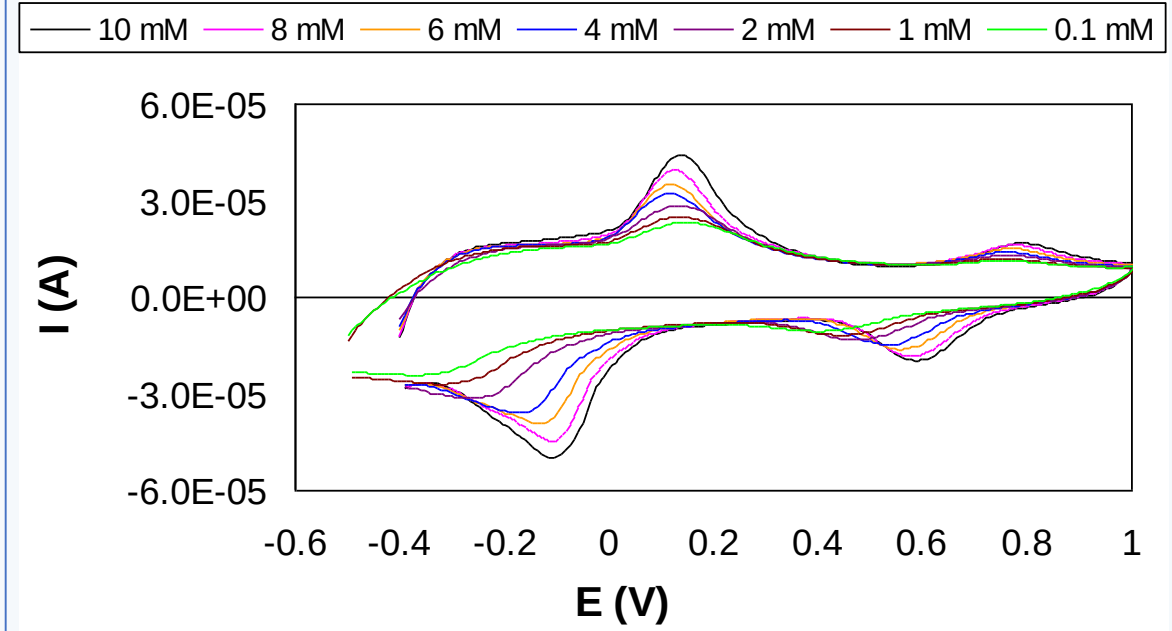
- The ATO-PB sensing material shows both pH and potassium concentration dependence.
- Linear increase of anodic and cathodic peak currents of both PB/ES and PB/BG redox systems in the presence of 100 µM caffeic acid.

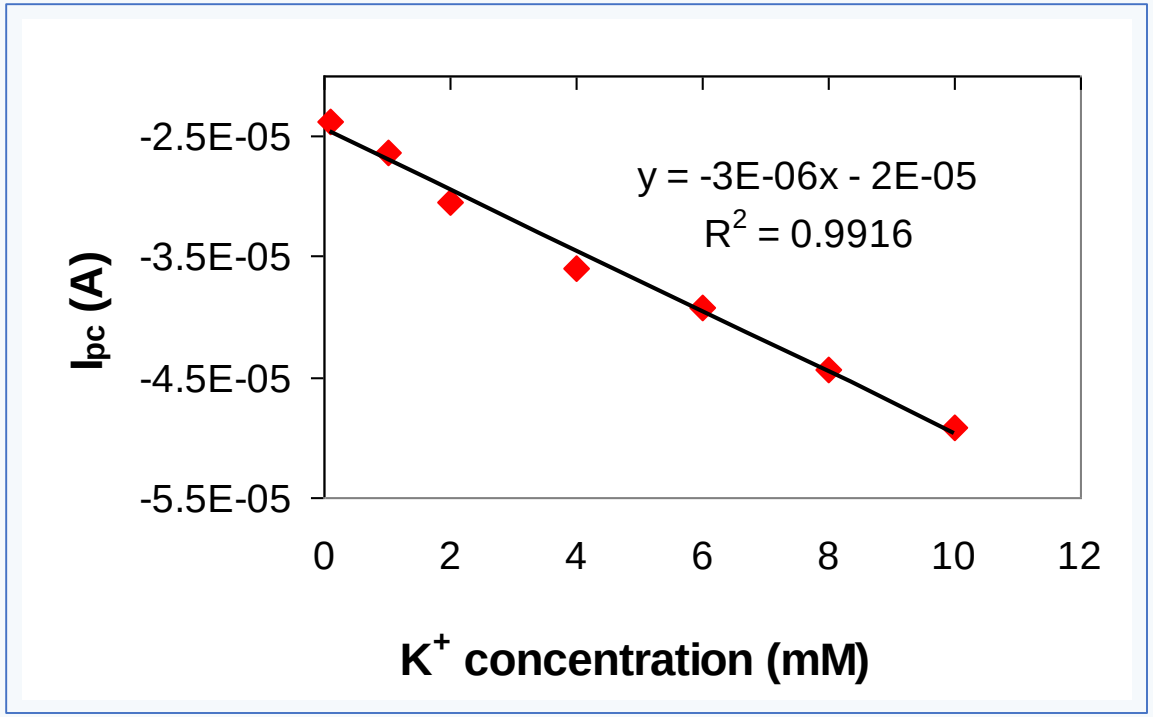




Results: Analytical applications

- The ATO – PB composite materials displayed good electron transfer capabilities.
- The electrochemical redox behavior of PB component underpin the electroanalytical applications towards the detection of electroinactive species.
- The cathodic peak current of the Prussian blue/Everitt's salt redox system depends linearly on the potassium ion concentration in the range 0.1 to 10 mM.





Conclusions

- The ATO-PB-SPEs displayed good electron transfer capabilities.
- The Prussian blue/Everitt's salt redox system shows reversible and stable electrochemical behavior in potassium containing aqueous solution.
- The ATO-PB composite material is sensitive to pH changes.
- The cathodic peak currents of the Prussian blue/Everitt's salt redox system have shown a linear dependence on the potassium concentration.
- The ATO-PB-SPE sensor displayed a wide linear response range towards potassium ions over the range 0.1 to 10 mM.
- These results show the potential applications of the ATO-PB-SPEs in the electrochemical sensing of electroinactive species.

Acknowledgments

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