

# MWCNT/Ti-doped ZnO nanocomposite as electrochemical sensor for detecting glutamate and ascorbic acid

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## Research Article

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# Abstract

Attributed to high stability and reproducibility, non-enzymatic electrochemical sensors have been extensively utilized in detection of various chemical substances. In this study, multi-walled carbon nanotube (MWCNT)/Ti-doped ZnO composite was prepared for fabrication of working electrode used in detection of glutamate and ascorbic acid. Ti-doped ZnO particles with the average size of  $44.47 \pm 4.05$  nanometers were synthesized by the solution combustion technique. Hydrothermal impregnation was employed in preparation of the MWCNT/Ti-doped ZnO composite. Electrocatalytic activities of the MWCNT/Ti-doped ZnO composite were examined using cyclic voltammetry technique. The cyclic voltammograms revealed the reduction reaction of glutamate close to -0.5 V, whereas the reduction reaction of ascorbic acid close to 0.05. Fair electrocatalytic performance, with acceptable sensitivity, limit of detection and selectivity suggested potential utilization of MWCNT/Ti-doped ZnO nanocomposite in detection of ascorbic acid and glutamate.

# Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

# Figures

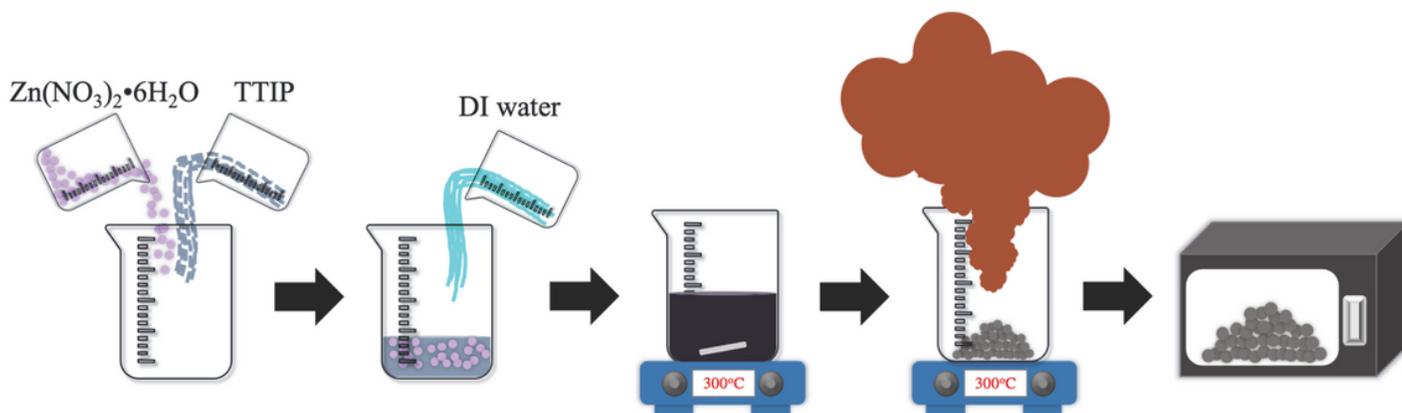
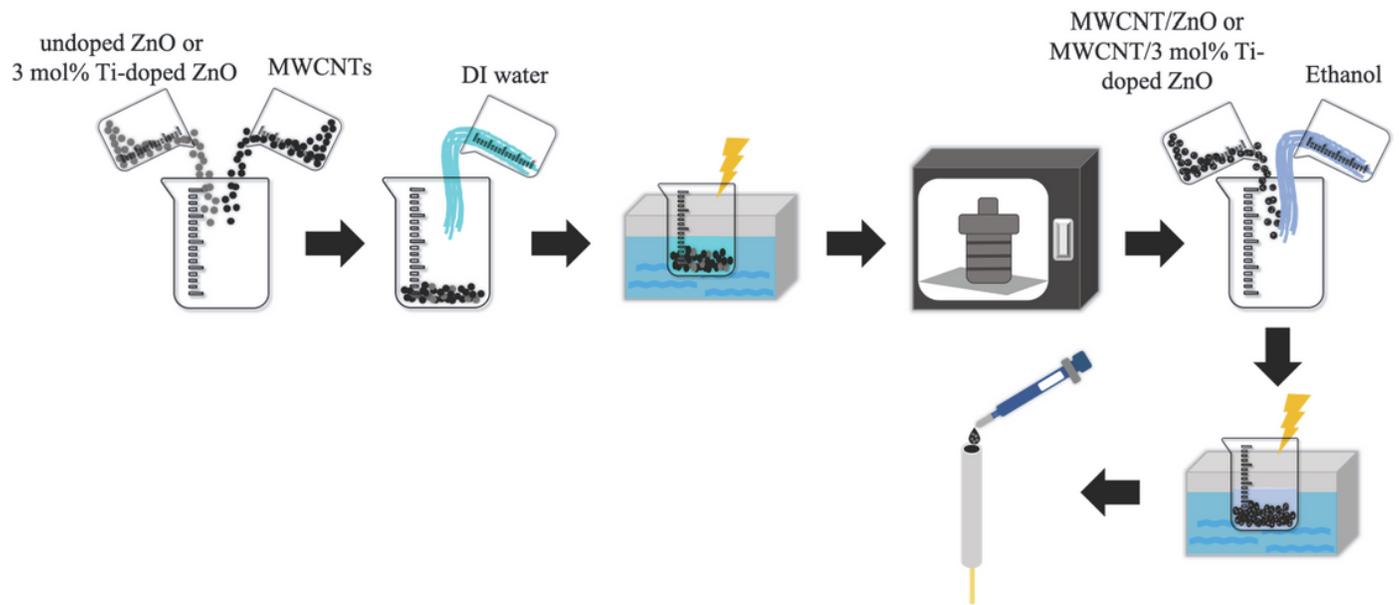


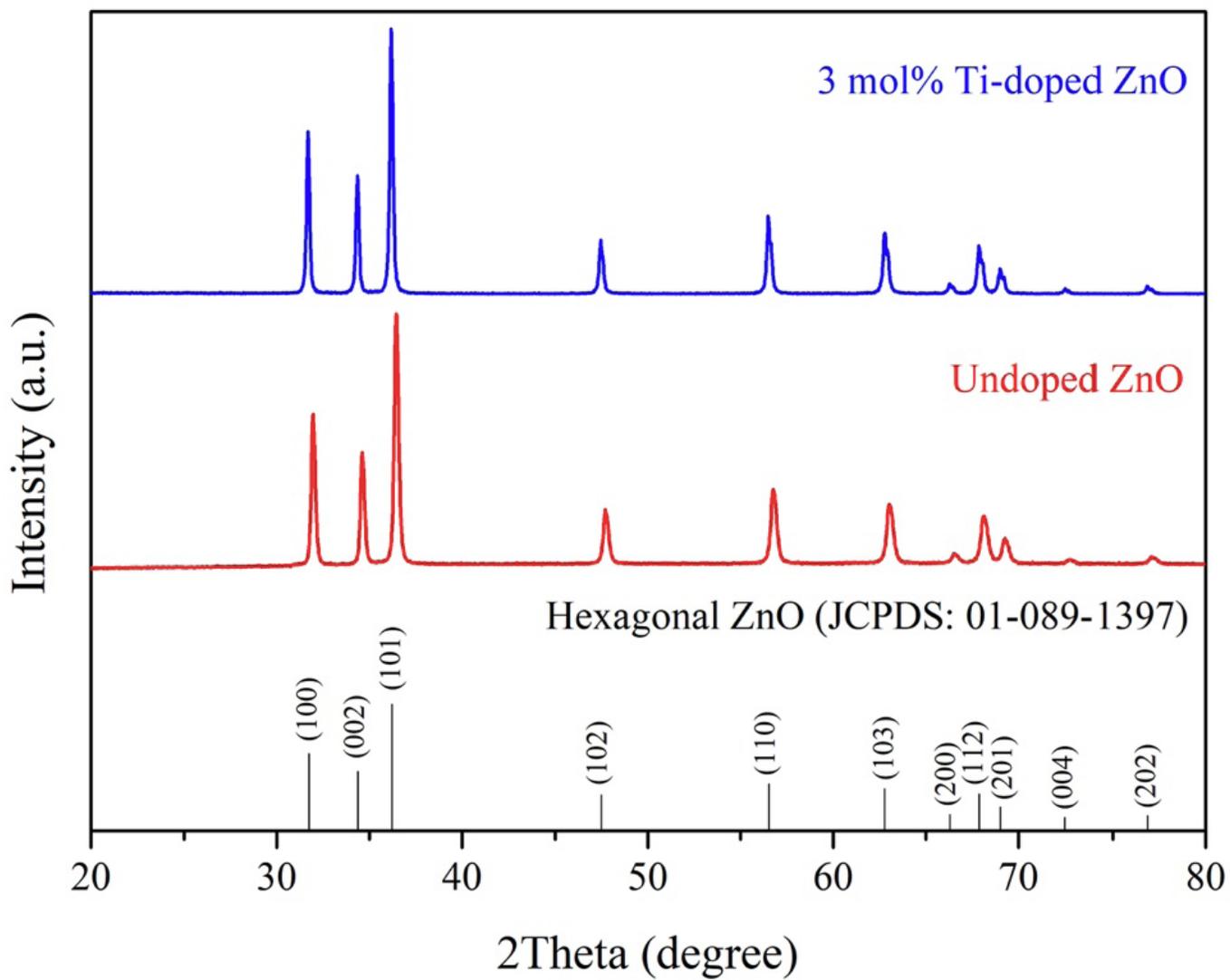
Figure 1

Schematic of the synthesis of undoped ZnO and 3 mol% Ti-doped ZnO powders.



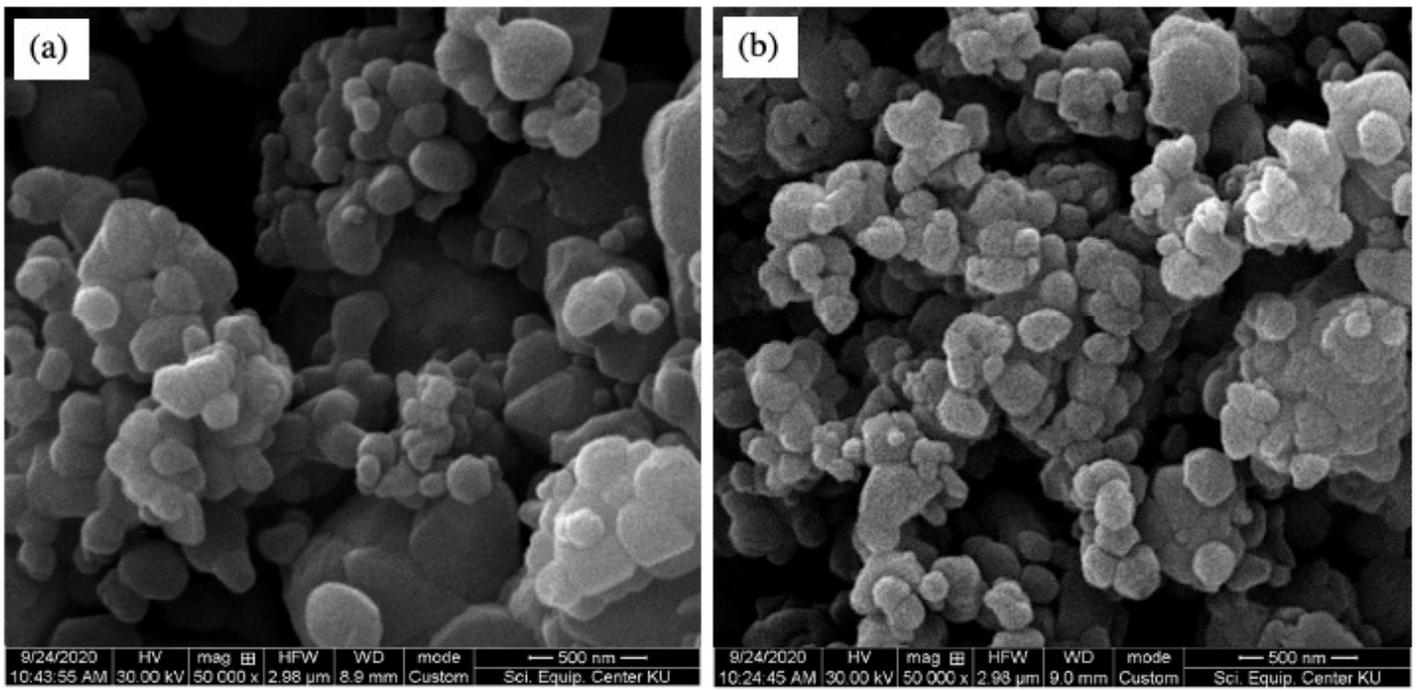
**Figure 2**

Schematic showing the steps for preparing MWCNT/undoped ZnO and MWCNT/3 mol% Ti-doped ZnO electrodes



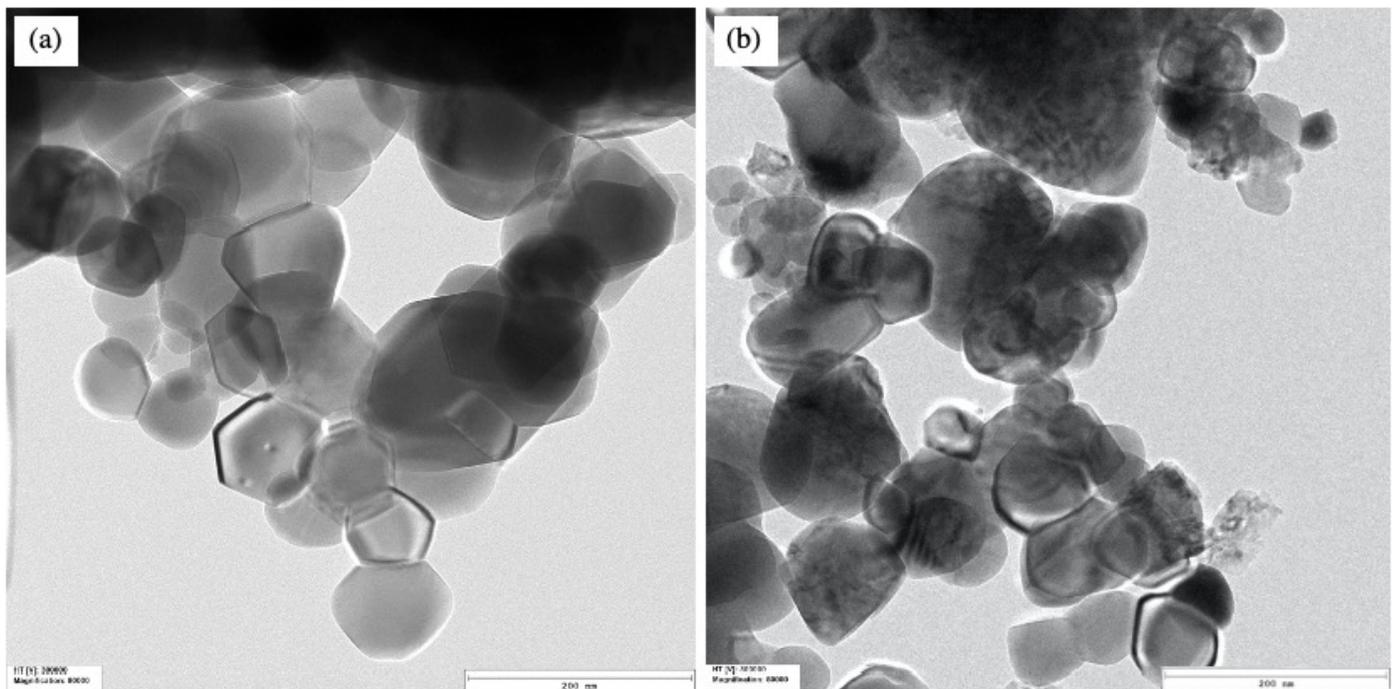
**Figure 3**

X-ray diffraction patterns of undoped ZnO and 3 mol% Ti-doped ZnO



**Figure 4**

Scanning electron micrographs of (a) undoped ZnO and (b) 3 mol% Ti-doped ZnO



**Figure 5**

Transmission electron micrographs of (a) undoped ZnO and (b) 3 mol% Ti-doped ZnO

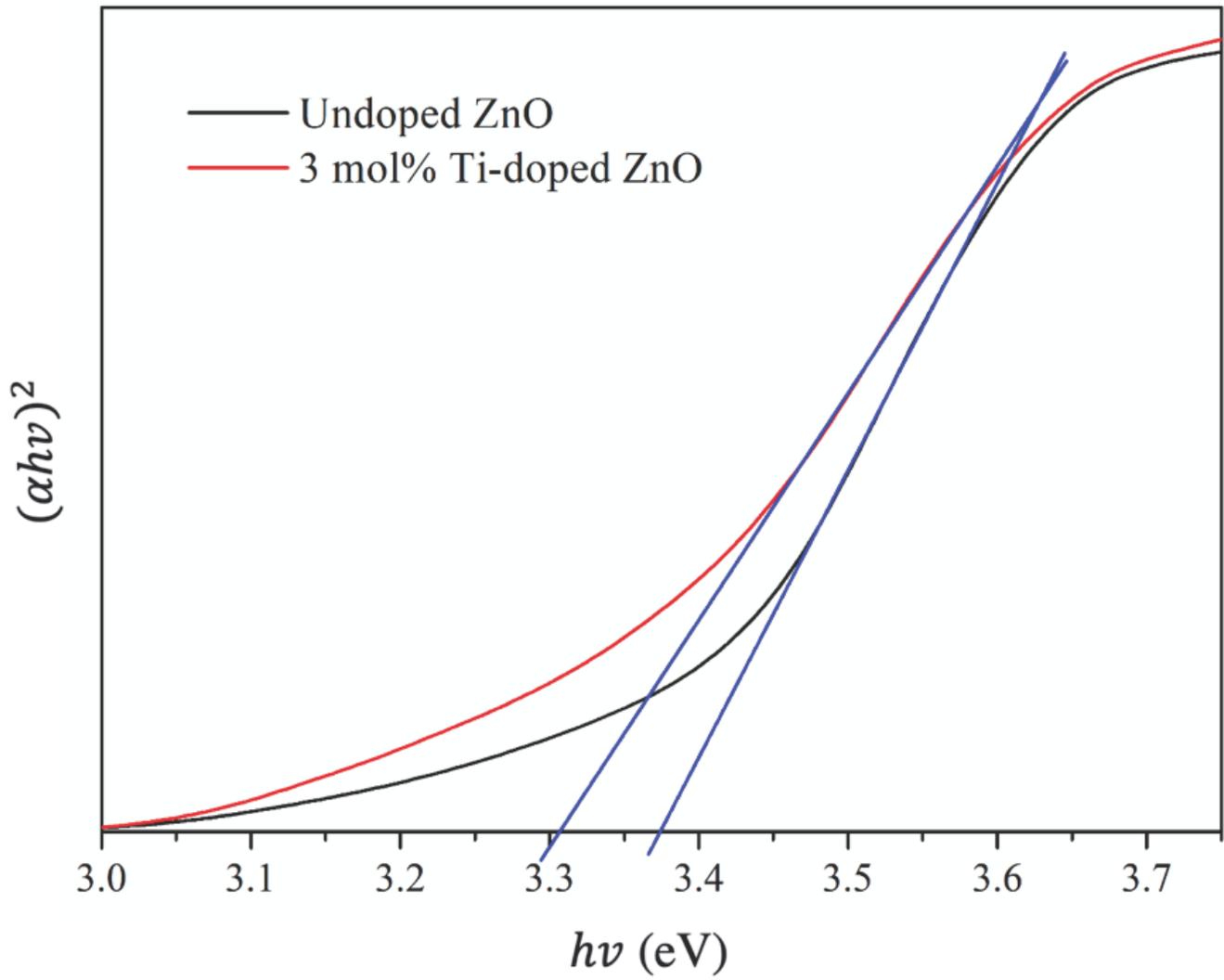
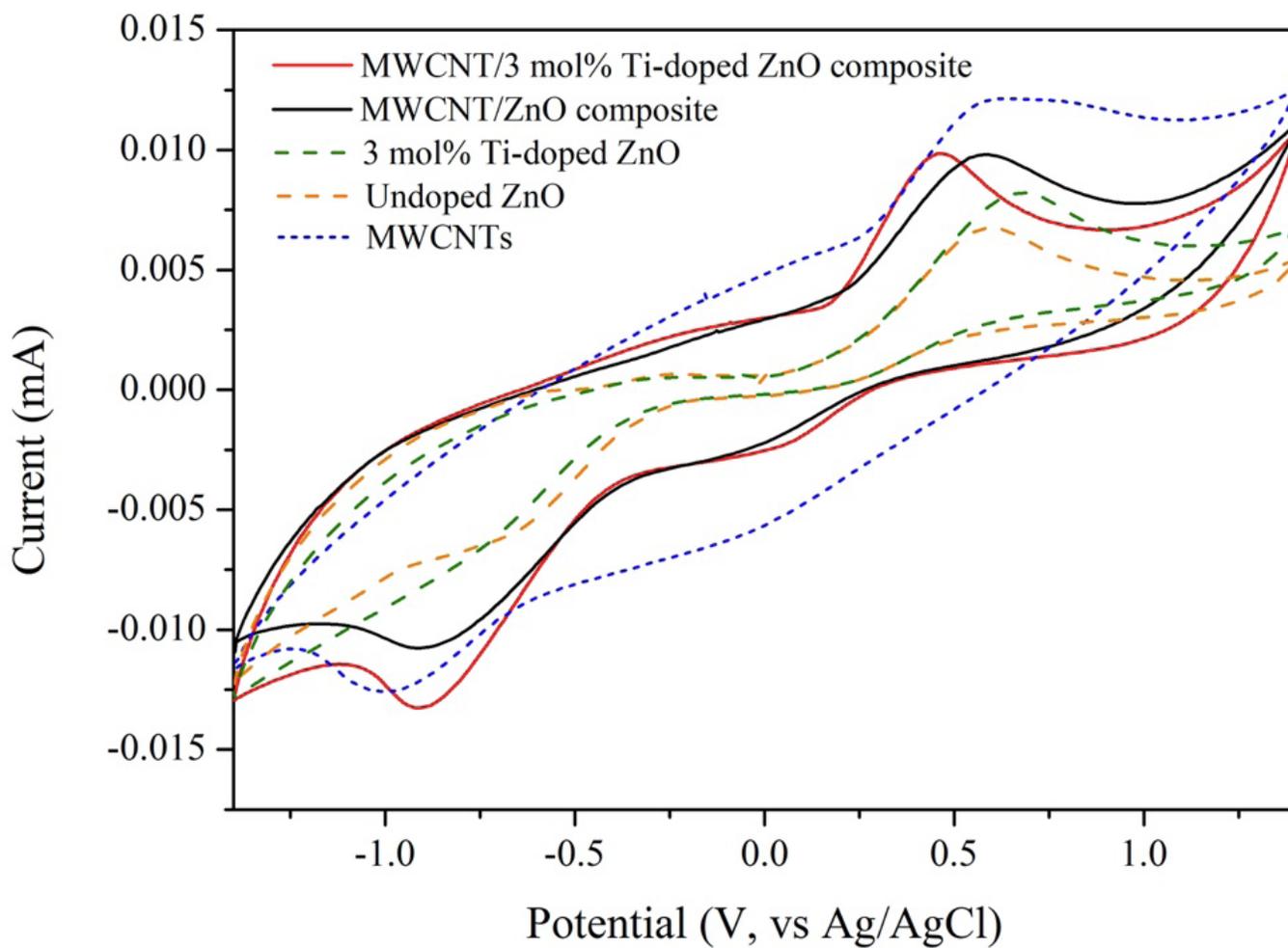


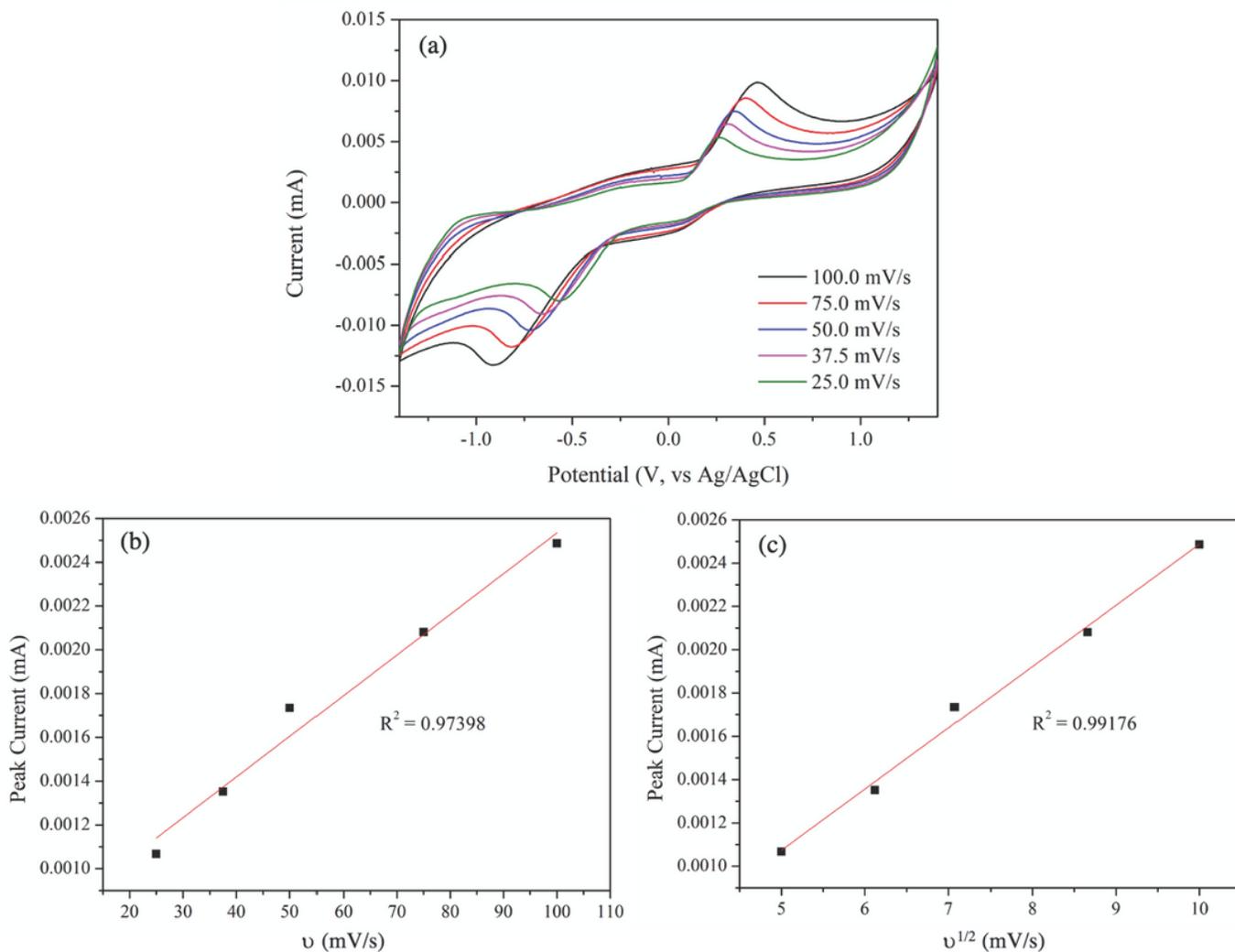
Figure 6

Tauc plots used to determine the bandgap energies of undoped ZnO and 3 mol% Ti-doped ZnO



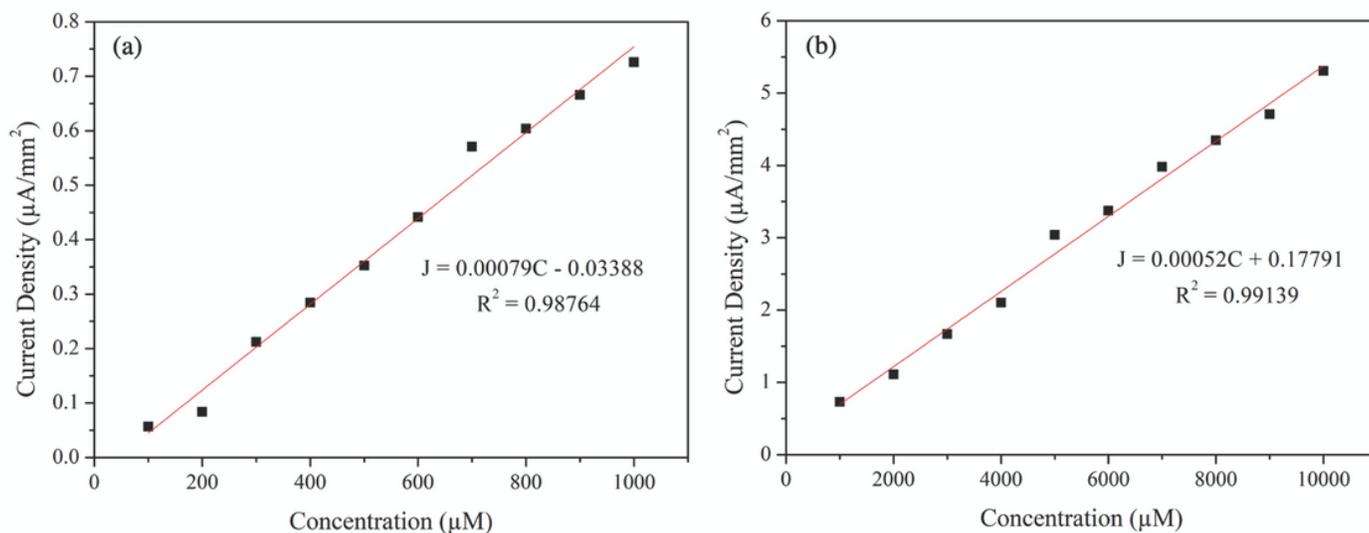
**Figure 7**

Cyclic voltammograms of MWCNTs, MWCNT/ZnO, and MWCNT/3 mol% Ti-doped ZnO electrodes in the presence of 500 μM ascorbic acid (AA), as recorded at a scan rate of 100.0 mV/s



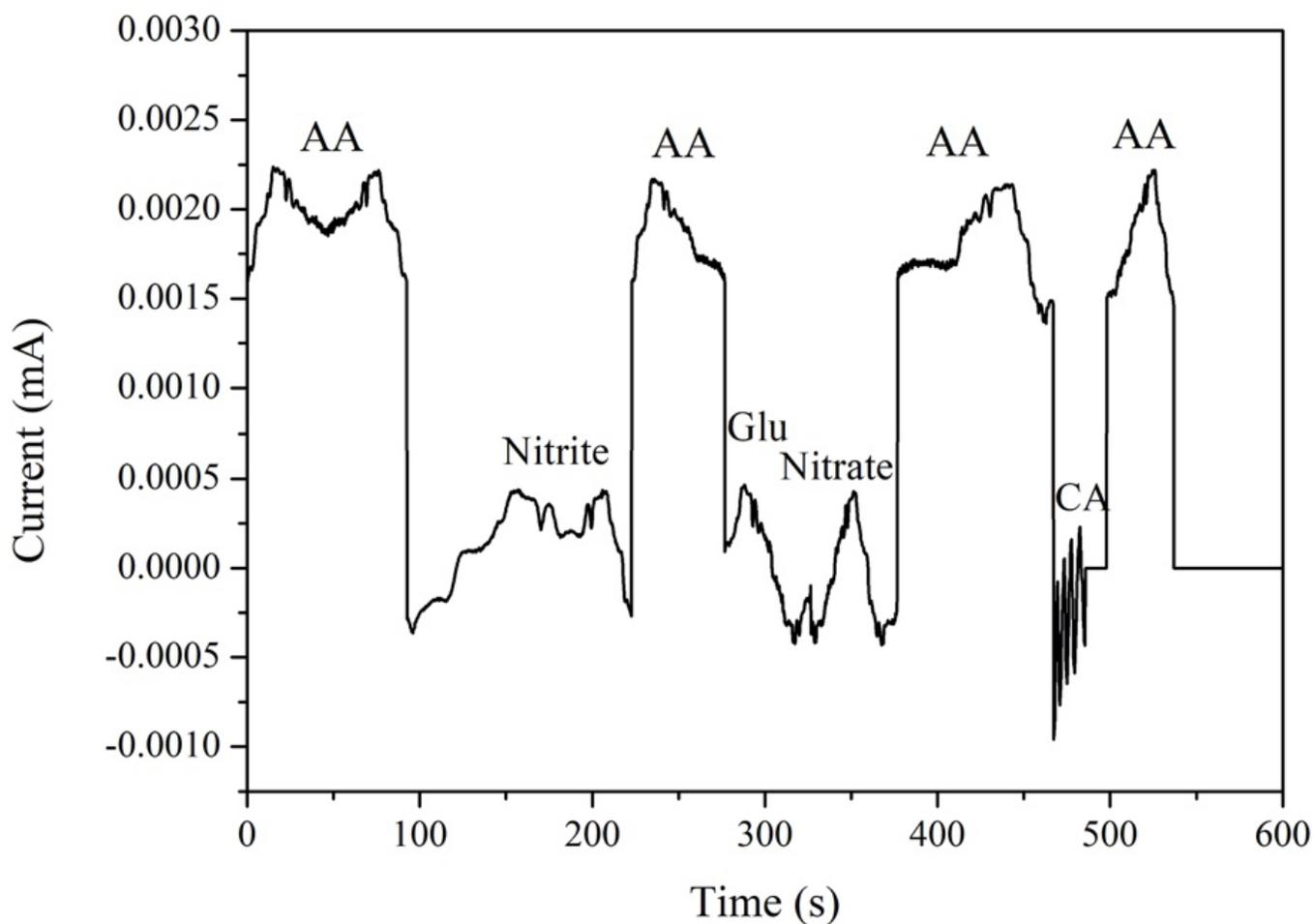
**Figure 8**

(a) Cyclic voltammograms of the MWCNT/3 mol% Ti-doped ZnO electrode at scan rates ranging from 25.0 to 100.0 mV/s; (b) the relationship between the peak current and the scan rate of the reduction reaction at 0.05 V in 500  $\mu$ M AA; (c) the relationship between the peak current and the square root of the scan rate of the reduction reaction at 0.05 V in 500  $\mu$ M AA



**Figure 9**

Calibration curves for the MWCNT/3 mol% Ti-doped ZnO in AA solutions with concentrations of (a) 100–1000  $\mu\text{M}$  and (b) 1000–10000  $\mu\text{M}$ , as recorded at a scan rate of 100.0 mV/s



**Figure 10**

Selectivity of a MWCNT/3 mol% Ti-doped ZnO electrode in the detection of 500  $\mu$ M ascorbic acid (AA), 500  $\mu$ M glutamate (Glu), 500  $\mu$ M nitrite, 500  $\mu$ M nitrate, and 500  $\mu$ M citric acid (CA)

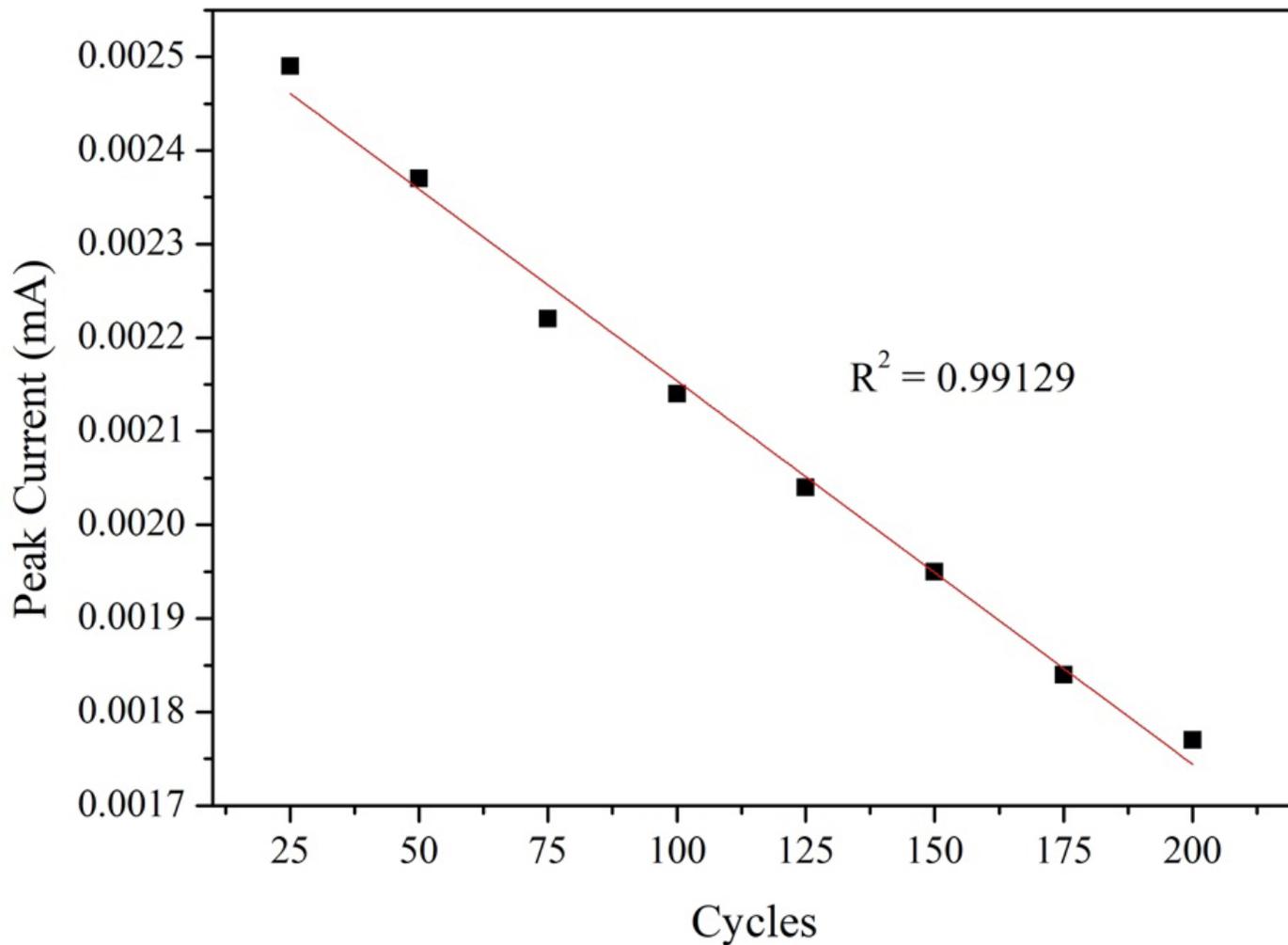
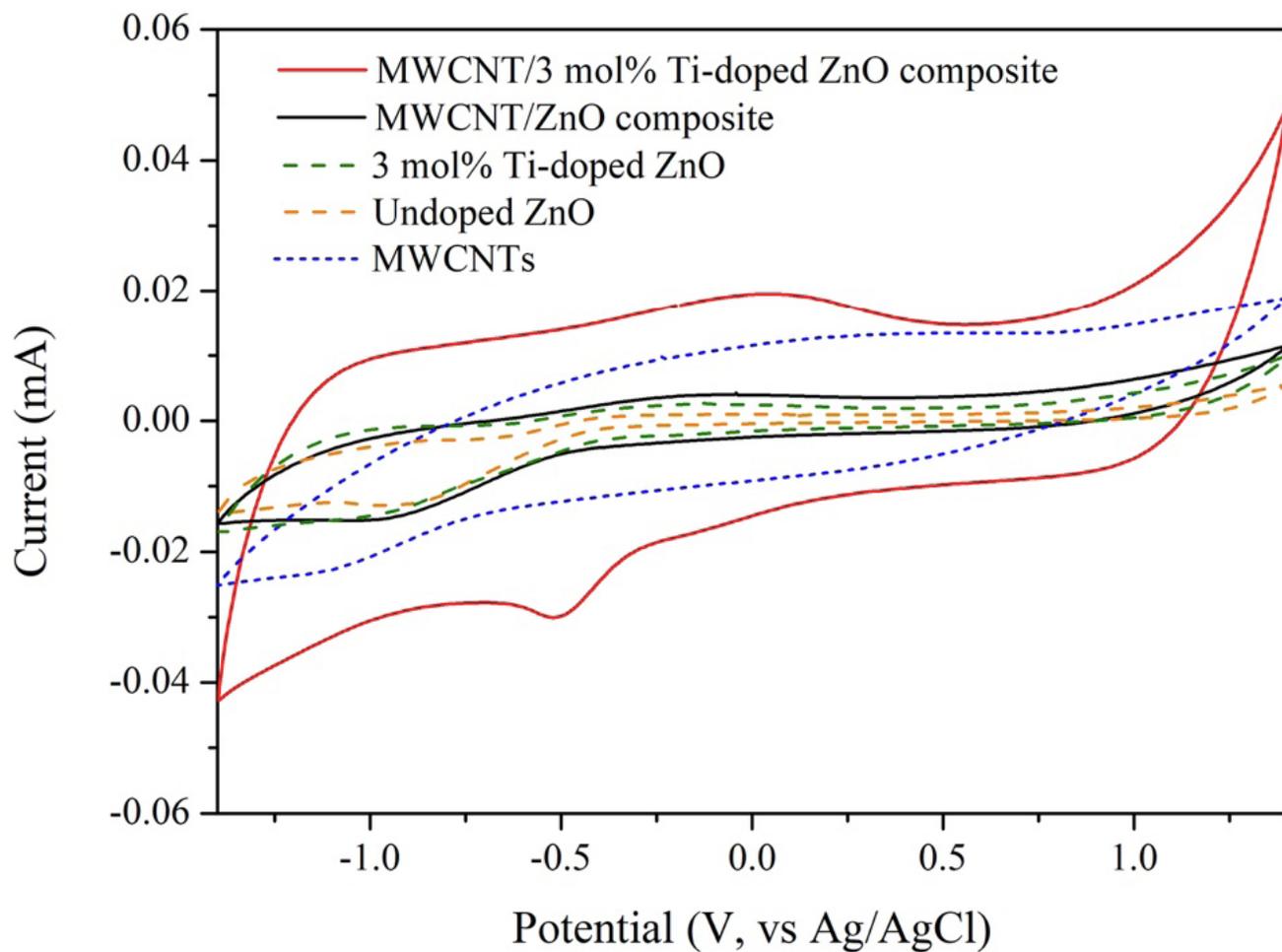


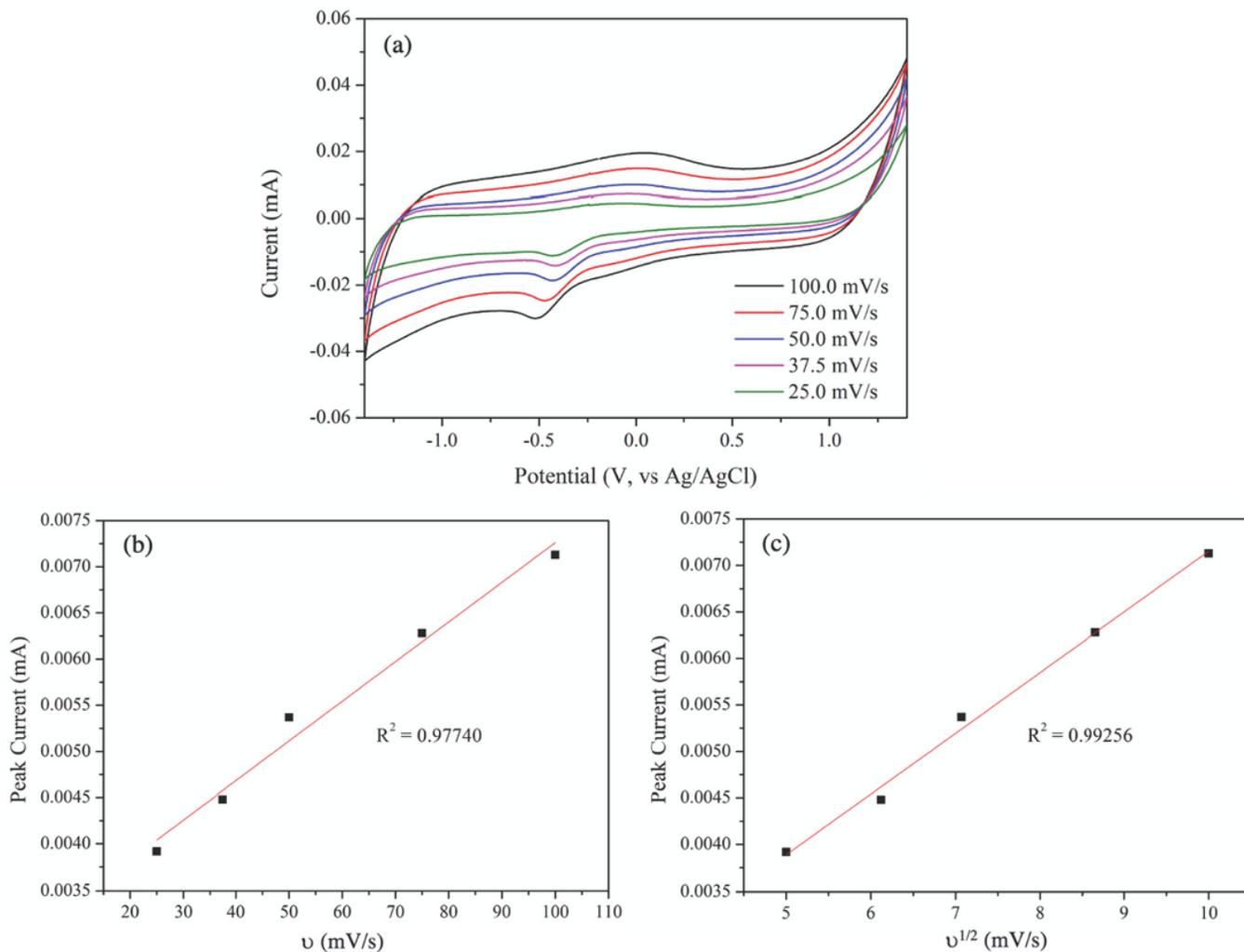
Figure 11

Reusability of the MWCNT/3 mol% Ti-doped ZnO electrode in 500  $\mu$ M AA at a scan rate 100.0 mV/s



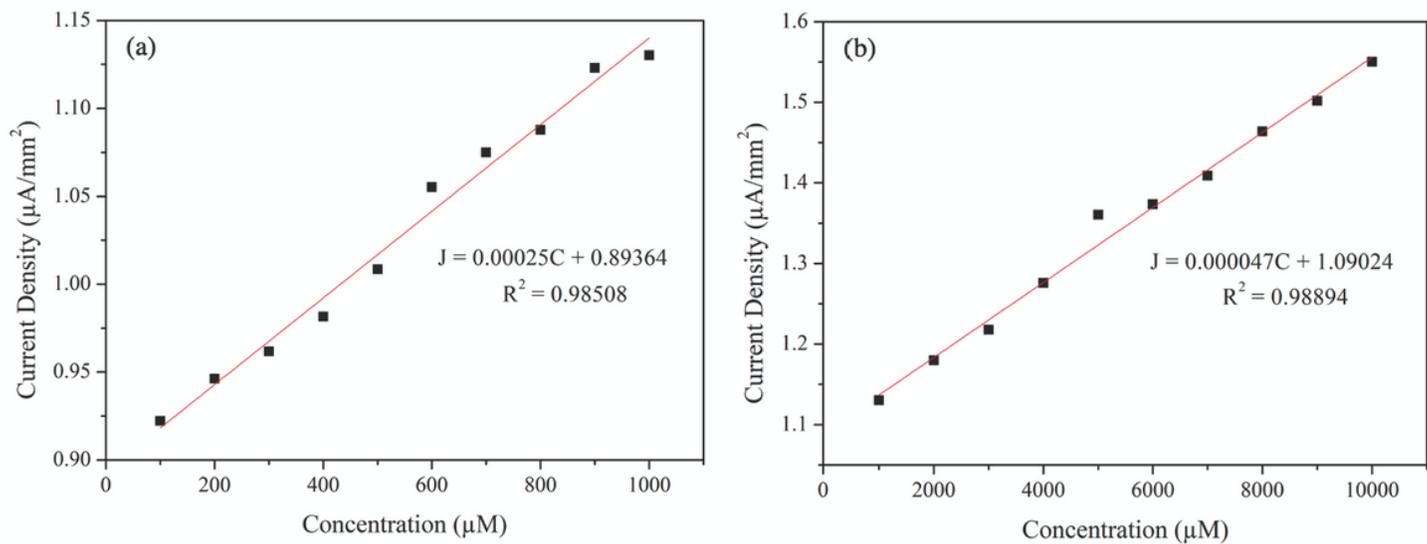
**Figure 12**

Cyclic voltammograms of MWCNTs, MWCNT/ZnO, and MWCNT/3 mol% Ti-doped ZnO electrodes in the presence of 500  $\mu\text{M}$  glutamate, as recorded at a scan rate of 100.0 mV/s



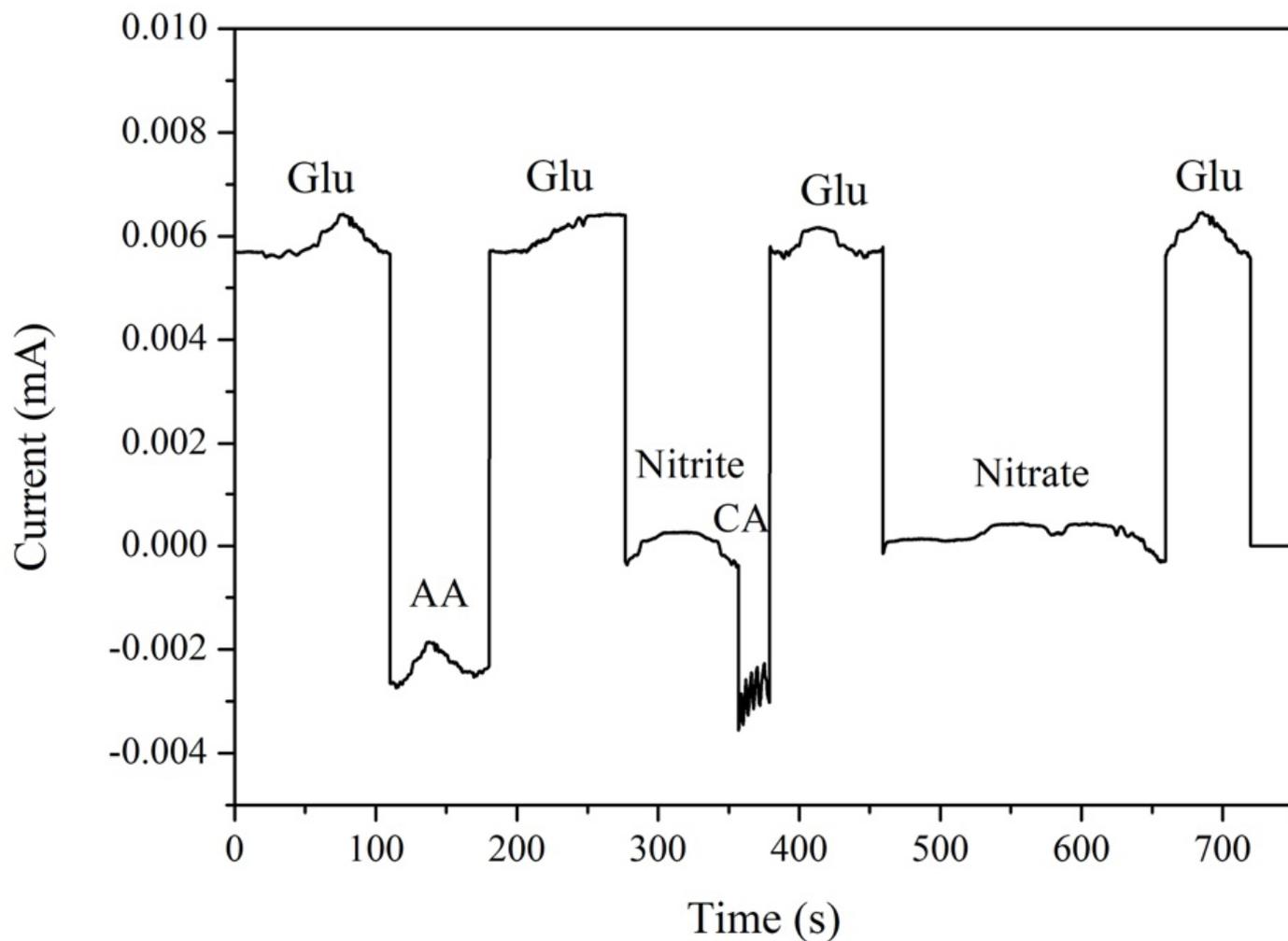
**Figure 13**

(a) Cyclic voltammograms of MWCNT/3 mol% Ti-doped ZnO electrodes at scan rates ranging from 25.0 to 100.0 mV/s; (b) the relationship between the peak current and the scan rate of the oxidation reaction at -0.5 V; (c) the relationship between the peak current and the square root of the scan rate of the reduction reaction at -0.5 V in 500  $\mu$ M glutamate



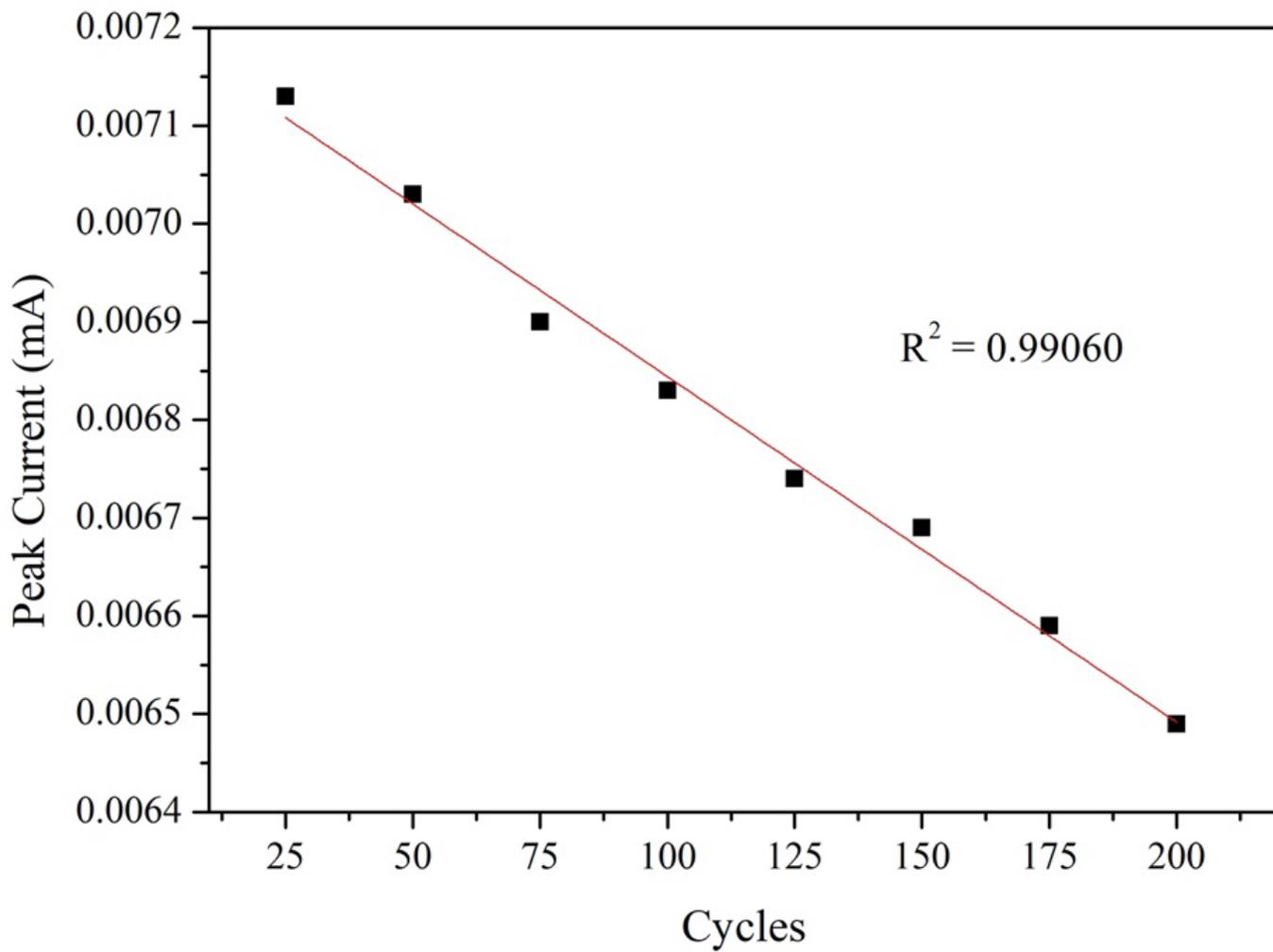
**Figure 14**

Calibration curves of the MWCNT/3 mol% Ti-doped ZnO electrode in glutamate at concentrations ranging (a) from 100 to 1000 μM and (b) from 1000 to 10000 μM, as recorded at a scan rate 100.0 mV/s



**Figure 15**

Selectivity of the MWCNT/3 mol% Ti-doped ZnO electrode in the detection of 500  $\mu\text{M}$  (Glu), 500  $\mu\text{M}$  AA, 500  $\mu\text{M}$  nitrite, 500  $\mu\text{M}$  nitrate, and 500  $\mu\text{M}$  CA



**Figure 16**

Reusability of the MWCNT/3 mol% Ti-doped ZnO electrode in 500  $\mu\text{M}$  glutamate at a scan rate 100.0 mV/s