Supporting Information

Engineering Carbon Nanotube Fiber for Real-Time Quantification of Ascorbic Acid Levels in a Live Rat Model of Alzheimer’s Disease

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1. The establishment of AD rat model.

The AD animal model was established according to previous report.\textsuperscript{43} Briefly, the rat model of AD was inducted through the combination of daily administration (i.p.) of D-galactose for six weeks and successive bilateral injection of ibotenic acid into rat nucleus basalis magnocellularis area, both of which have been demonstrated to be able to accelerate brain aging and cause neurodegeneration in the end. Male Wistar rats, weighing 100-120 g were used to establish the AD animal model, and the normal Wistar rats were used as a control group.
2. TEM images of as-purified MWCNTs and MWCNT with amorphous carbon

![TEM images](image1)

**Figure S1.** TEM images of (A) as-purified MWCNTs and (B) enlarged image of MWCNT with a little amorphous carbon.

3. CVs obtained at CNF microelectrodes in the presence of Fe(CN)$_6^{3-}$

![CV plots](image2)

**Figure S2.** (A) Typical CVs at carbon fibre (I) and CNF after treated by acid (II) in aCSF containing 5 mM Fe(CN)$_6^{3-}$. (B) CVs at CNF microelectrodes in the absence of AA (I) and in presence (II) of 1 mM AA.
4. Typical Raman spectra CNF and d-CNF obtained at 200 °C.

**Figure S3.** Raman spectra of CNF ($I_D/I_G$: 0.65, blue line (II)) and d-CNF-1 treated at 200°C ($I_D/I_G$: 1.5, red line (I)).
5. TEM images of MWCNT in d-CNF after heating treatment at 300, 400 °C and after electrochemical treatment.

**Figure S4.** STEM image of the MWCNT in (A) d-CNF-2 at 300 °C, (B) d-CNF-3 at 400 °C, and (C) e-CNF.
6. XPS spectra of MWCNTs in various CNFs.

![XPS spectra](image)

**Figure S5.** Typical XPS spectra for the d-CNF-3 (I), o-CNF-1 (II) and e-CNF (III) after electrochemical treatment.

7. FTIR spectra recorded at as-prepared CNF, and e-CNFe

![FTIR spectra](image)

**Figure S6.** FTIR spectra recorded at as-prepared CNF (I), and e-CNFe (II).
8. The pH dependence of $J_p^0$ values.

Figure S7. $J_p^0$ values in aCSF solution with different pH values.
9. Selectivity for AA towards electroactive neurochemicals

Figure S8. (A) DPV responses obtained at e-CNf microelectrode in aCSF (pH 7.4) in the absence or presence of AA, DOPAC, DA, UA, and 5-HT. (B) DPV responses obtained at e-CNf microelectrode in aCSF solution (pH 7.4) in the absence (I) and presence of 500 μM AA, DA, DOPAC, UA, and 5-HT (II).

![Graph](image)

**Figure S9.** DPVs obtained at the e-CNF microelectrode before (I) and after (II) 1000 continuous cycles of scanning in aCSF (pH 7.4).

11. Anti-biofouling ability to protein.

![Graph](image)

**Figure S10.** $J_p/J_p^0$ values under different time in aCSF containing 500 μM AA and 4% BSA.
12. Reproducibility

Figure S11. (A) Reproducibility test for six CNF microelectrodes (from 1 to 6) with the addition of 1 mM AA versus Ag/AgCl in artificial cerebrospinal fluid (aCSF) (pH 7.4). (B) The $J_p/J_p^0$ values taken from Figure S7A of six sensors.

13. The concentrations of AA determined in three regions of normal rat brains and rat brains with AD by the present method.

Table S1. Concentrations of AA determined by the present method in three regions of normal rat brains and AD rat brains.

| Concentration of AA ($\mu$M) | Normal rats | | | Rats with AD | | | |
|-----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
|                             | Rat 1       | Rat 2       | Rat 3       | Mean±SD     | Rat 1       | Rat 2       | Rat 3       | Mean±SD     |
| Cortex                      | 250         | 256         | 287         | 264 ± 20    | 220         | 177         | 235         | 210 ± 30    |
| Striatum                    | 254         | 260         | 265         | 259 ± 6     | 183         | 185         | 177         | 182 ± 5     |
| Hippocampus                 | 277         | 235         | 263         | 261 ± 21    | 115         | 137         | 156         | 136 ± 20    |
14. DPVs comparison for AA detection in rat brain before and after microinjection of aCSF (pH 7.4).

![Graph showing DPVs comparison for AA detection](image)

**Figure S12.** DPV responses recorded at the e-CNF microelectrode in the striatum of the AD rat brain before (I) and after (II) microinjection of aCSF (pH 7.4) for 15 min.

15. The electrode-to-electrode reproducibility.

![Graph showing electrode-to-electrode reproducibility](image)

**Figure S13.** (A) Reproducibility test for five e-CNF microelectrodes (from 1 to 5) monitored in striatum of rat brains with AD. (B) The $J_p/J_0$ values taken from Figure S8A of five sensors.
16. AA Concentrations in rat brains followed by ischemia under different time.

**Figure S14.** The AA alteration in rat brain followed by cerebral ischemia for 60 min in different brain regions: striatum (A), hippocampus (B) and cortex (C).