Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A

Electronic Supplementary Information

Enhancing Catalytic Formaldehyde Oxidation on CuO-Ag_2O Nanowires for Gas Sensing and Hydrogen Evolution

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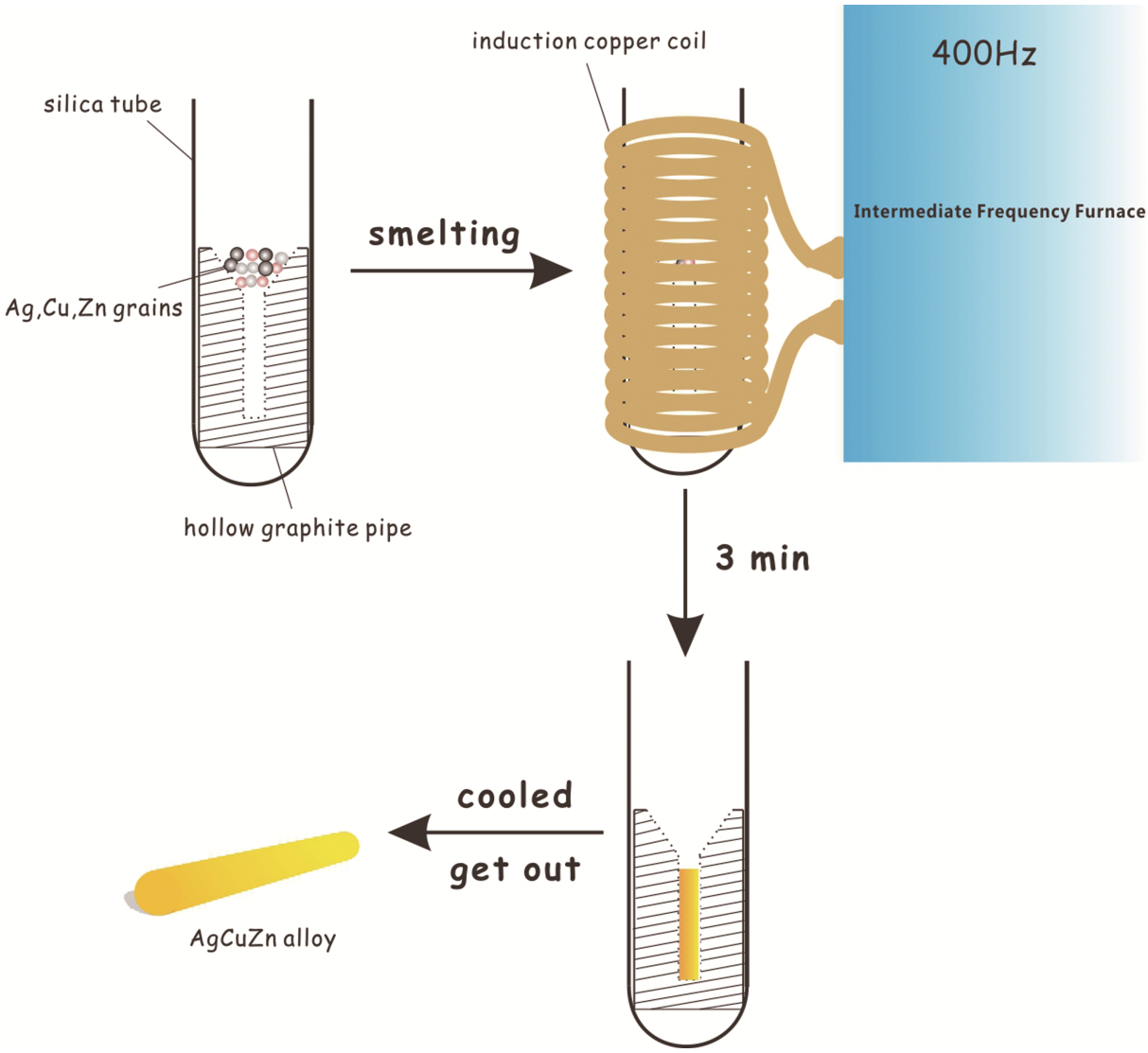

Scheme S1. The procedure of AgCuZn alloy fusion via an intermediate frequency furnace.

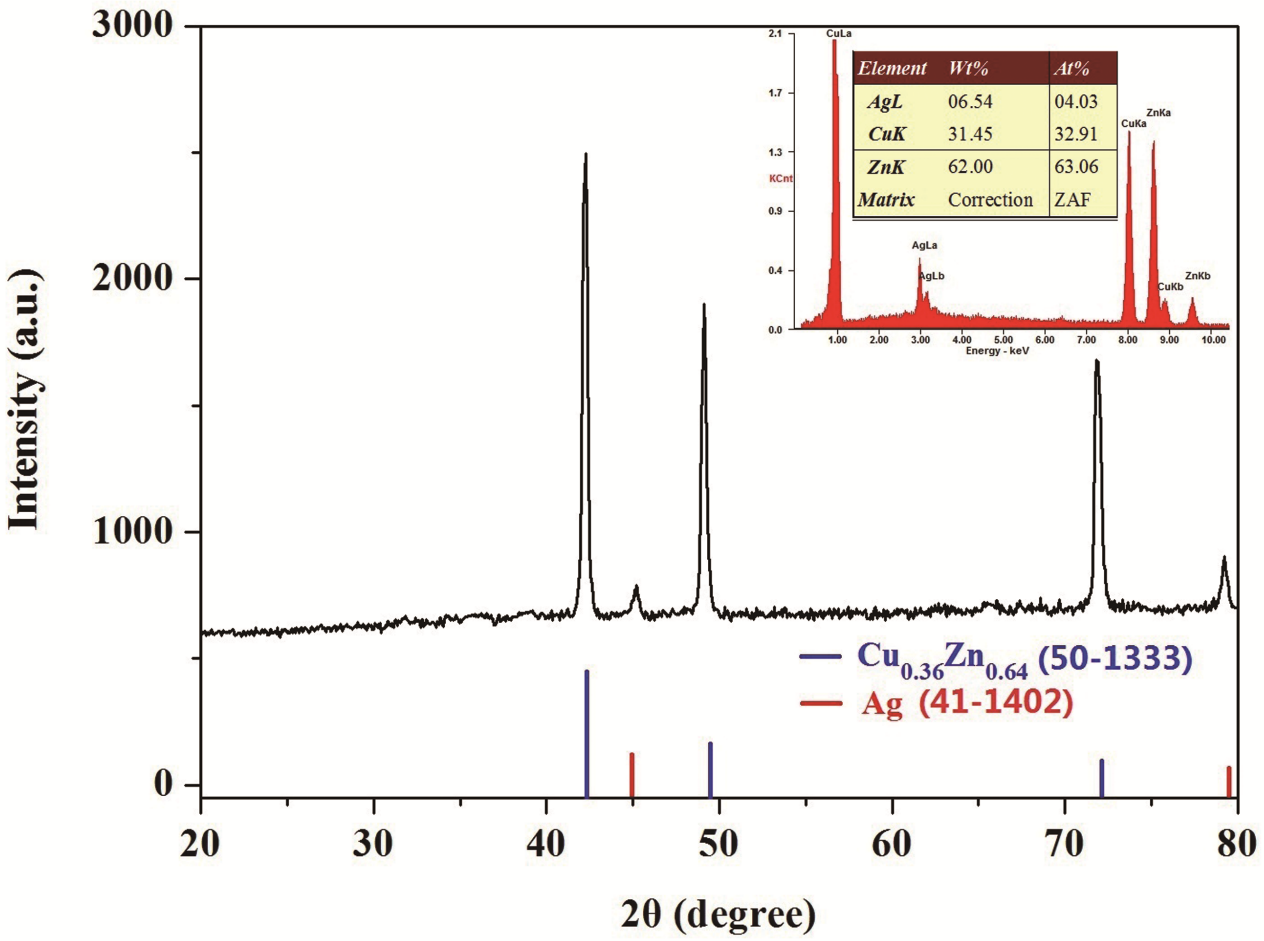

Fig. S1 XRD pattern of the AgCuZn substrate and the codes of JCPDS file are provided in the brackets; The EDS spectrum and element compositions of the substrate which studied majorly in this paper (inset).

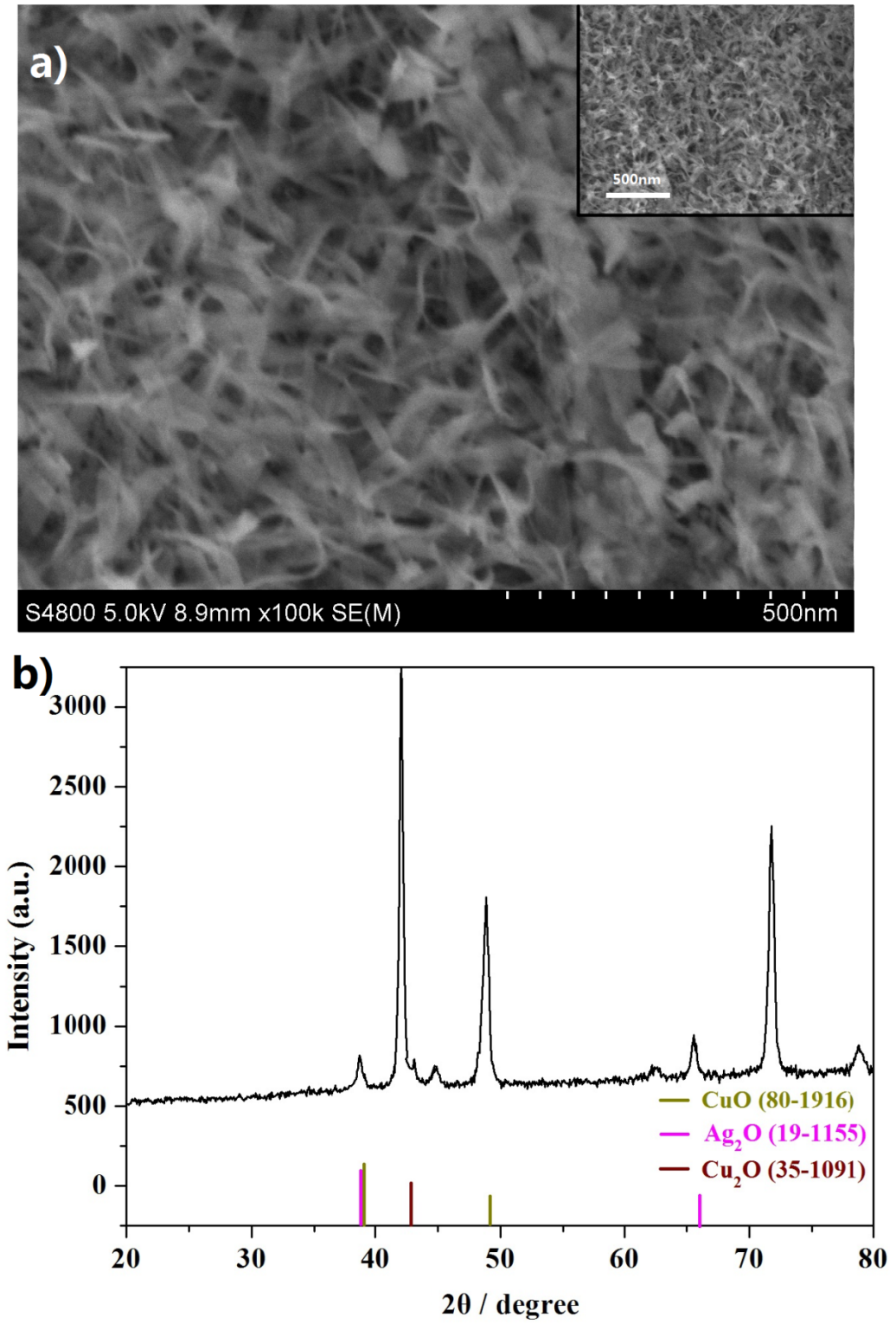

Fig. S2. a) SEM image of oxide nanofibers grown on AgCuZn alloy after Na_2O_2 oxidation; b) XRD pattern of the nanofibers modified alloy. The unmarked peaks are the substrate same as Fig. S1.

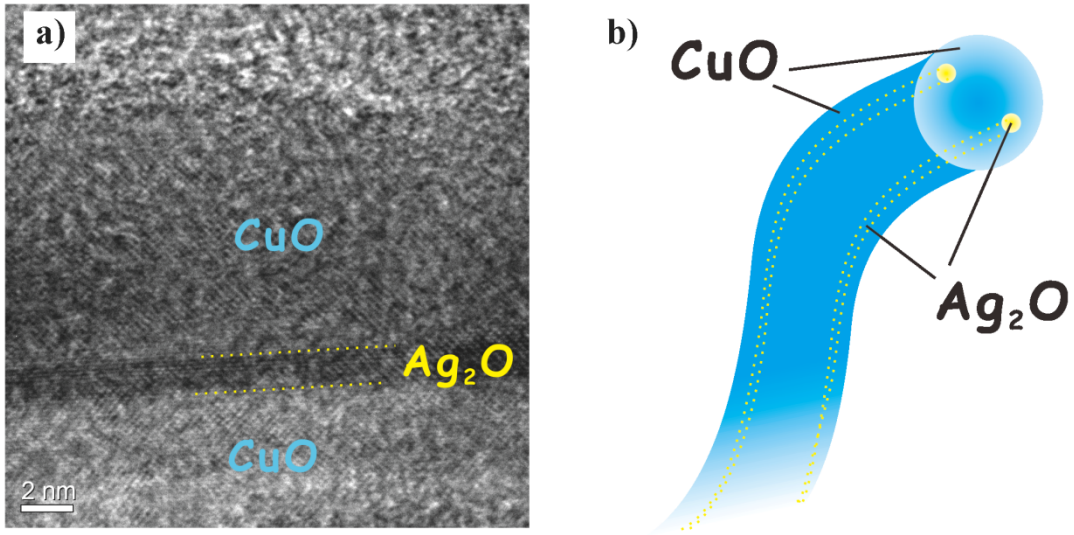

Fig. S3. a) a HRTEM image of a CuO-Ag_2O nanowire; b) schematic core-shell structure of a single nanowire which was composited by two phases.

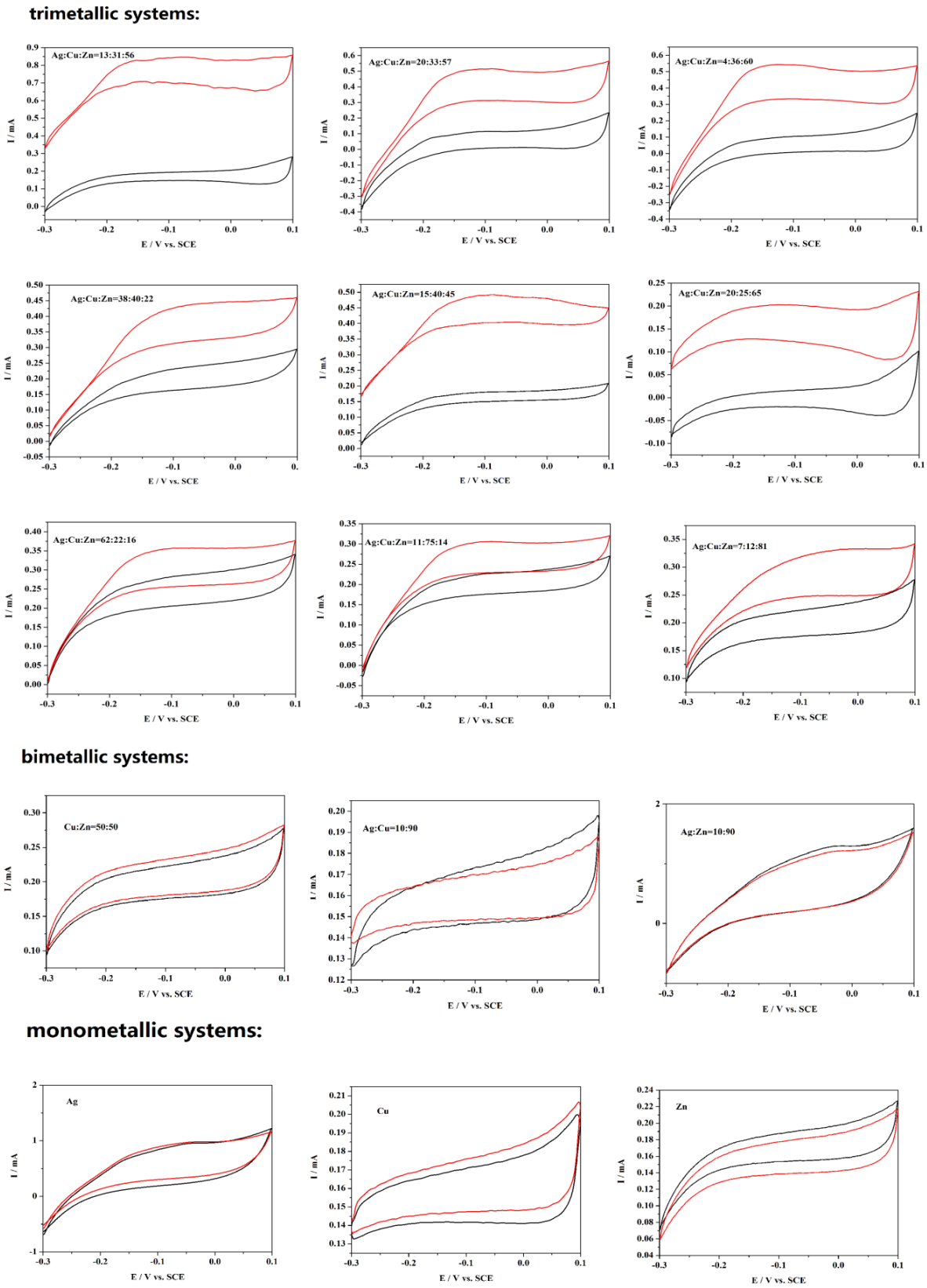

Fig. S4. Some typical CV curves of the alloys in different mass fraction and single metals treated in the same procedure (0.5M Na_2O_2 solution for 40 min at 45℃ and 300℃ heat-treatment for 3 h). The tests are in 0.15 M KOH with (red line) and without (black line) 1 mM formaldehyde.

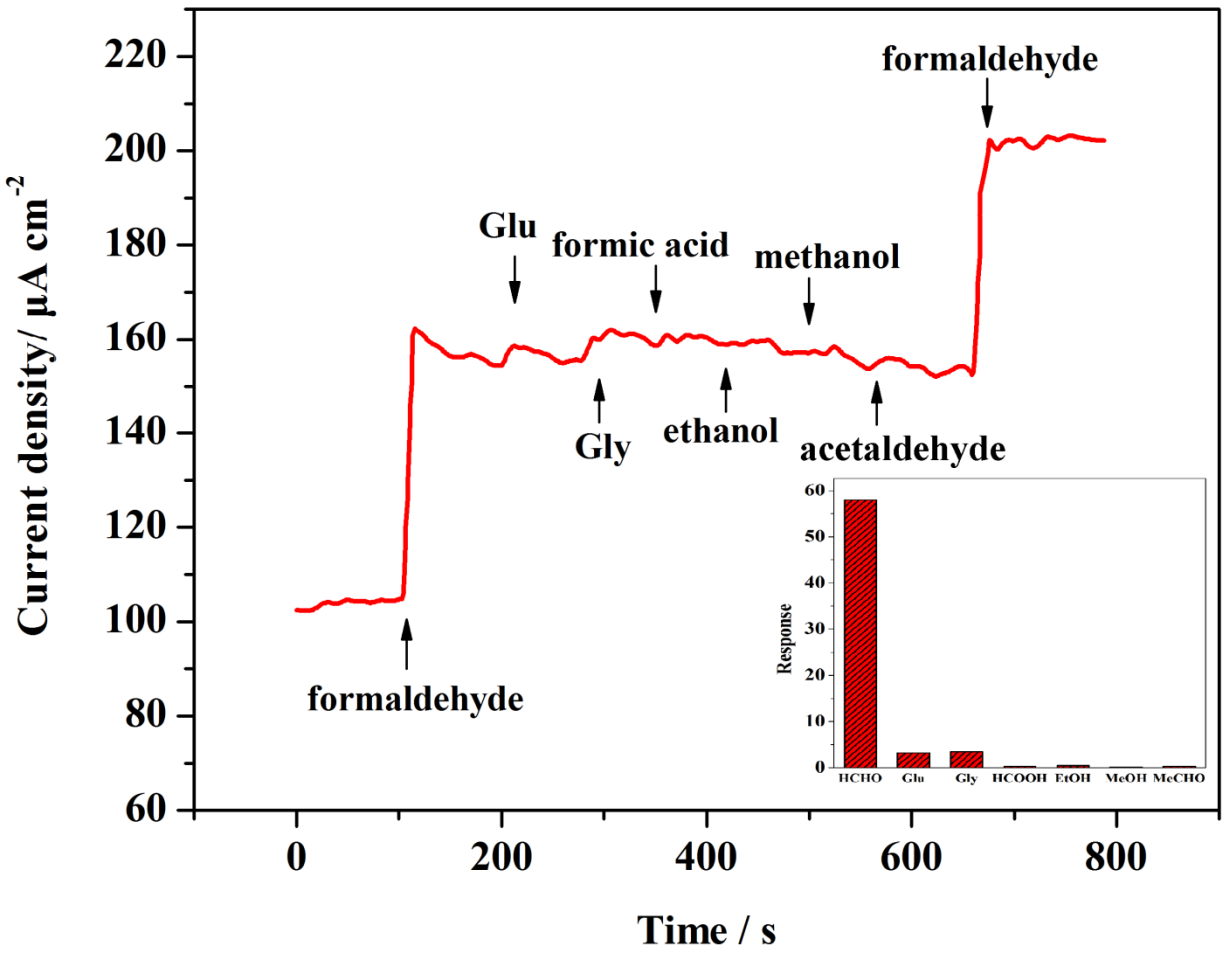

Fig. S5. Amperometric response at -0.15 V vs. SCE of the sensor to 0.1 mM formaldehyde, 0.1 mM glutamic acid, 0.1 mM glycine, 0.1 mM formic acid, 0.1 mM ethanol, 0.1 mM methanol, 0.1 mM acetaldehyde.

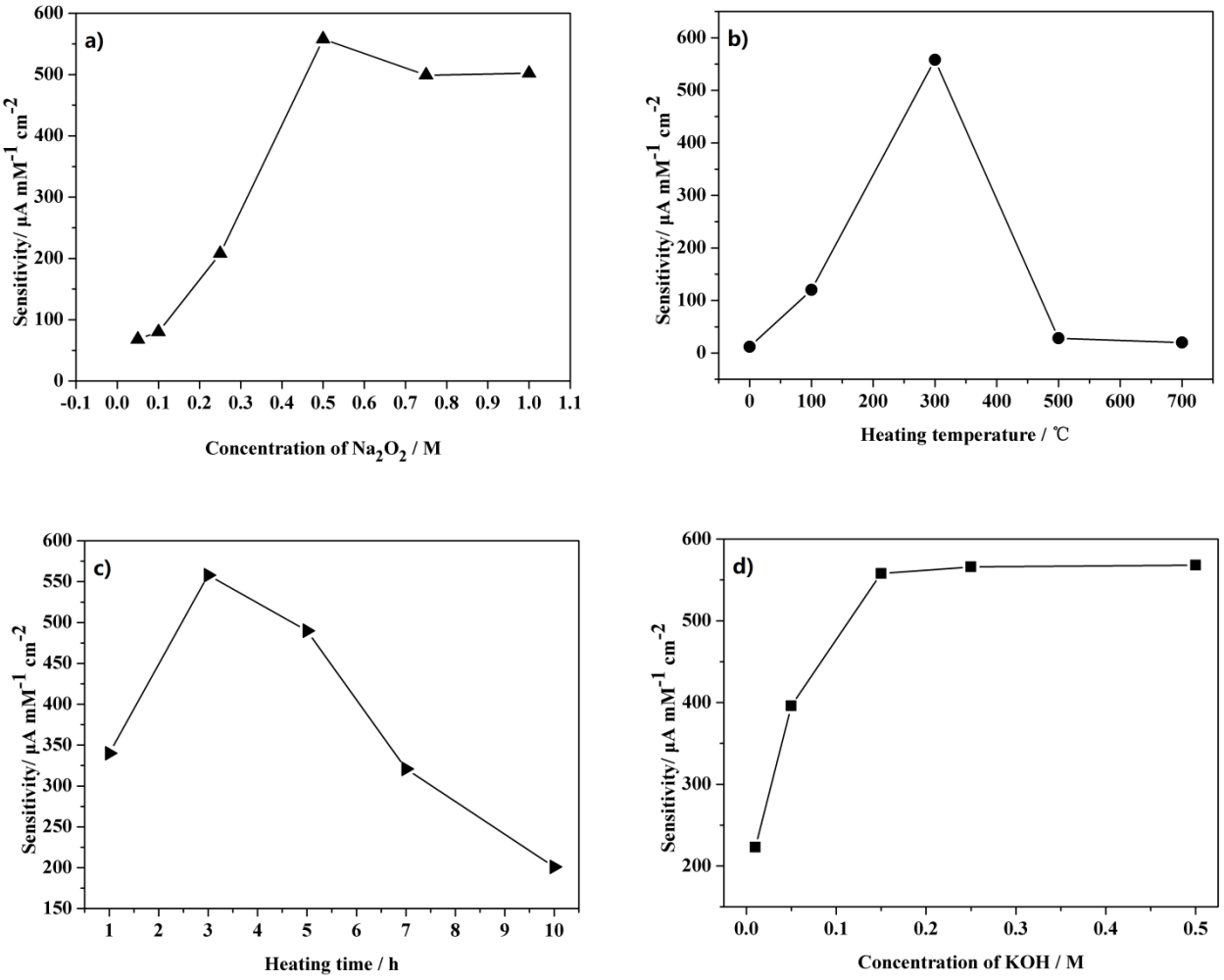

Figure S6. The effect of a) concentration of oxidant (Na_2O_2), b) heating temperature, c) heating time and d) concentration of KOH electrolyte on activity of formaldehyde oxidation. As we see, the best suitable concentration of Na_2O_2 for nanofibers growth is 0.5 M and the heating temperature of CuO-Ag_2O NWs generation is 300 ℃ for 3 hours. The proper KOH electrolyte for HCHO assay is 0.15 M.

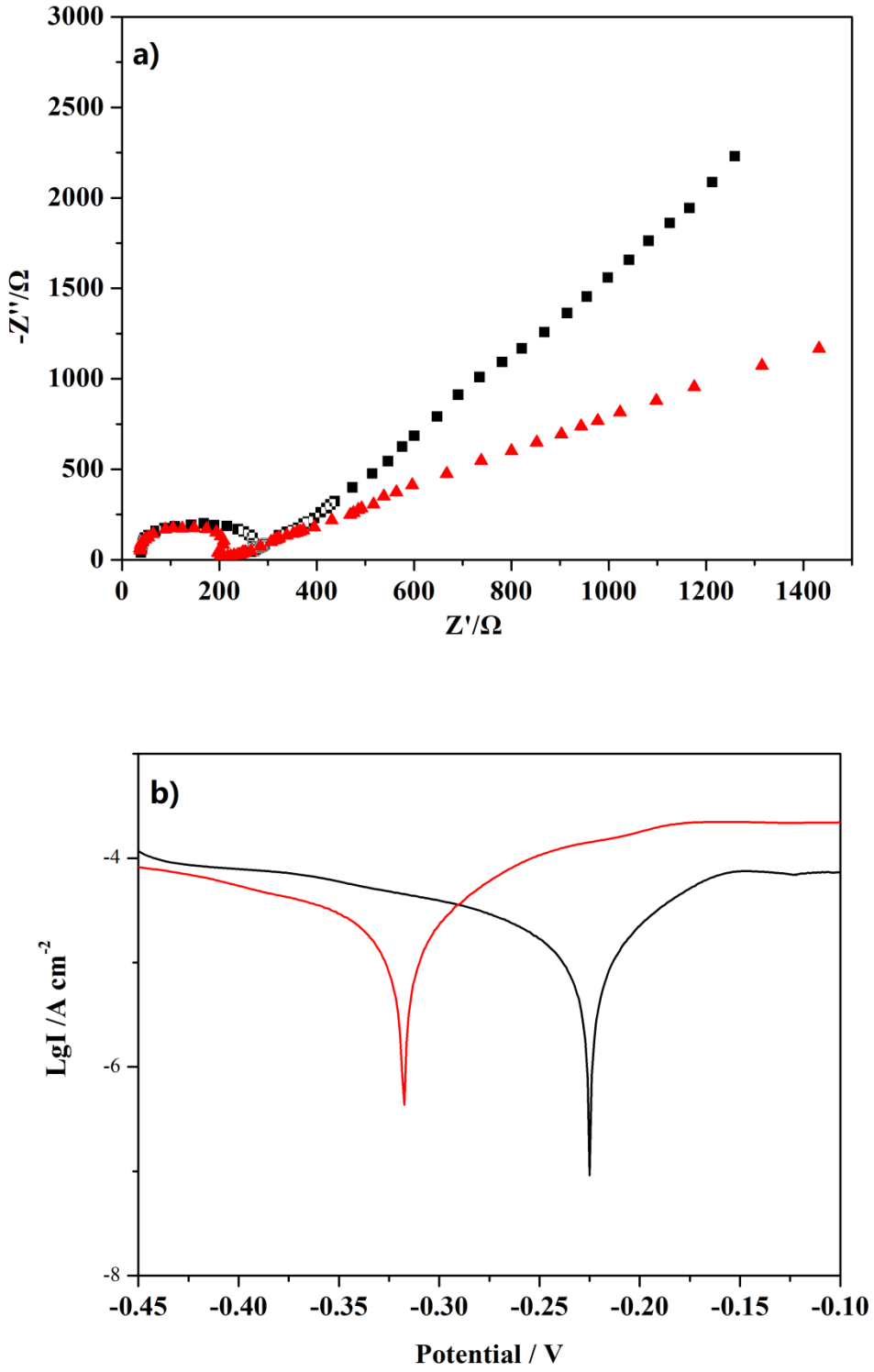

Figure S7. a) Nyquist spectrums of electrochemical independence spectroscopy (EIS) with (red triangle) and without (black square) formaldehyde in 0.15 M KOH; b) Potentiodynamic polarization curves of the modified electrode in 0.15 M KOH with (red line) and without (blank line)

formaldehyde.

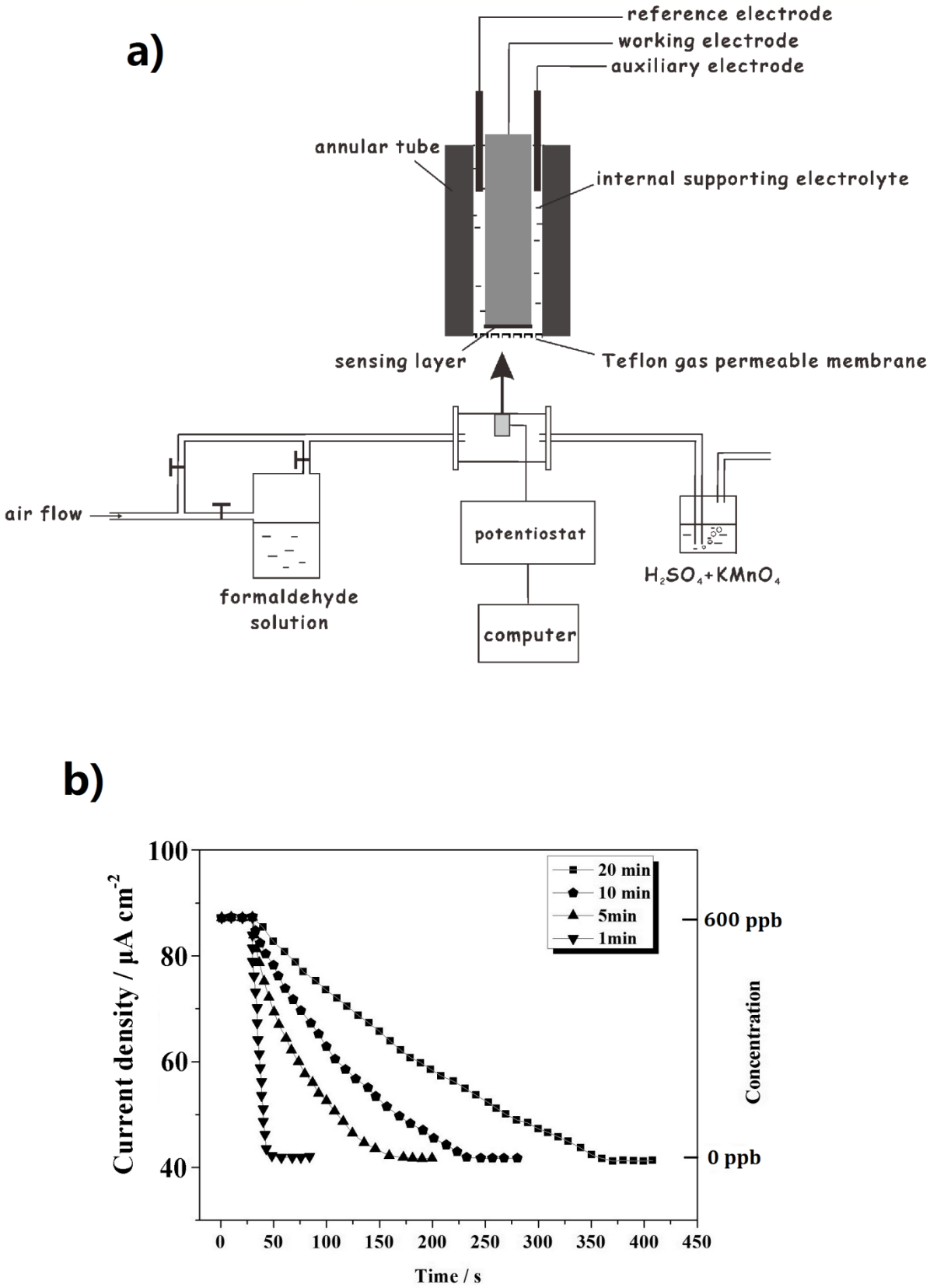

Figure S8. a) Schematic diagram of the gas sensing instrument; b) The restoring time after 20, 10, 5 and 1 min exposure of the sensor to 600 ppb HCHO.

detection method	sensitivity	detection limit	response time	restoring time
Spectrophotometry[1]	-	50-200 ppb	5~30 min	not provided
sol-gel based optical sensor[2]	-	30 ppb	6 h	incapable
pH indicator based colorimetry[3]	-	50 ppb	10 min	incapable
formaldehyde dehydrogenase based electrode[4]	0.32 μA cm^{-2} ppm^{-1}	300 ppb	0.5-1 h	more than 2 h
gold coating Nafion modified elet-rode[5]	1.11 μA cm^{-2} ppm^{-1}	13 ppb	2 min	10 min
In_2O_3 nanorods based sensor (test at 300 ℃)[6]	0.78 ppm^{-1} (R_0/R)	8000 ppb	69 s	78 s
α-Fe_2O_3 hollow spheres based sen-sor[7]	0.20 ppm^{-1} (R_0/R)	10000 ppb	not provided	not provided
ZnO quntum dots/graphene composites based sensor[8]	32.68 ppm^{-1} (R_0/R))	not provided	30 s	40 s
this work	52.40 μA cm^{-2} ppm^{-1}	21 ppb	3~5 s	4~6 s

Table 1. Comparison between various methods for formaldehyde detection in vapor.

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