Electronic Supplementary Information

Label-free impedimetric sensing platform for microRNA-21 based on ZrO_2-reduced graphene oxide nanohybrids coupling with catalytic hairpin assembly amplification

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1. Experimental section

1.1 Cell culture: MCF-7 (human breast cancer cell lines) and 293T (human emborynic kidney cell lines) cell lines were purchased from ATCC (Manassas, VA). All cells were cultured in RPMI 1640 medium (Gibco, Grand Island, NY) containing 10% FBS and 5% penicillin-streptomycin at 37 °C in a 5% CO_2 humid atmosphere. After the cell concentration reached 80%, the next cell experiments could be done. Cell density was determined using a hemocytometer prior to each experiment.

1.2 miRNA-21 extracts from cancer cells: The MCF-7/293T cells were grown to around 80% confluency for 24 h before the experiment. Total RNAs of MCF-7/293T cells were extracted with TRIzol reagent (Thermo, shanghai, China) according to the manufacturer's protocol. Then, the cleared lysate was flash frozen, and stored at -80 °C before use. The stored solution was further consecutively diluted with deionized water in order to obtain the proper solution for detection (our proposed methods).

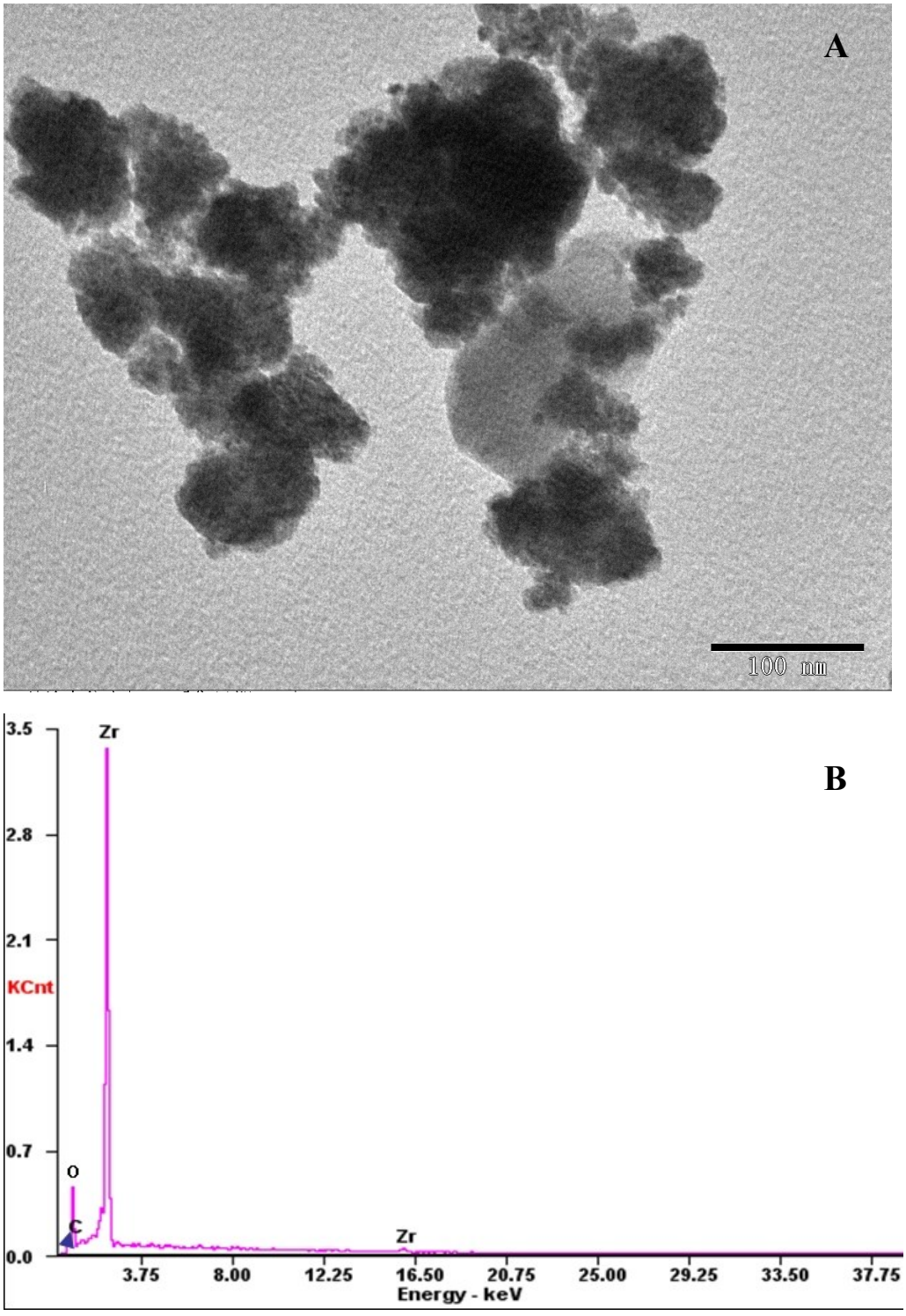

Figure S1. TEM images (A) and EDX (B) of ZrO_2-RGO.

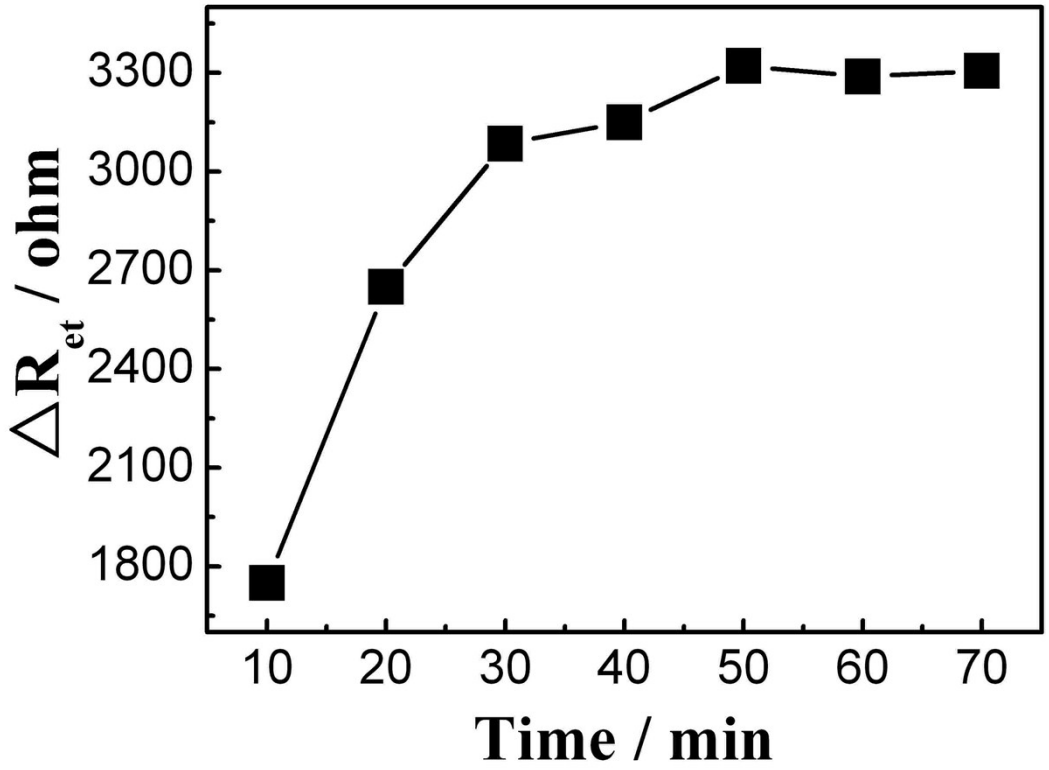

Figure S2. The influence of the hybridization time on $\triangle R_{et}$.

Table S1. The sequences of DNA and RNA used in this work

Names		From 5′ to 3′
Hairpin DNA	H1	ATAAGCTATCTACACATGGTAGCTTATCAGACTCCATGTGT AGA - ($CH_2)_6$-NH_2
	H2	TCAACATCAGTCTGATAAGCTACCATGTGTAGATAGCTTAT CAGACTCCTAATGGTGTGGC
miRNA-21		UAGCUUAUCAGACUGAUGUUGA
miRNA-141		UAACACUGUCUGGUAAAGAUGG
Three-base mismatched miRNA-21(t-miRNA-21)		TAGCUUAUCAGCCUGAUGUTGA

Table S2. Comparison of linear range and detection limit of the reported sensors

Sensors	Technique	Linear range	Detection limit	Reference
ssDNA/AuNPs/PNR/GCE	DPV	0.01 nM – 17 nM	4.2 pM	1
PNA/poly(JUG-co-JUGA)/GCE	SWV	10 nM – 100 nM	10 nM	2
ssDNA/PICA/GCE	CV	3.34 nM – 10.6 nM	1.0 nM	3
ssDNA/ZrO2/ SWNTs/PDC/GCE	EIS	10 pM – 1.0 μM	1.38 pM	4
ssDNA/AuNPs/GO/GCE	DPV	60 pM –0.6 nM	27pM	5
H1/PAA/ZrO_2-RGO/GCE	EIS	10 fm – 0.1 nM	4.3 fM	This work

Table S3. Determination results of miRNA-21 in human serum

Sample Num.	Added (pM)	Found (pM)	Recovery (%)
1	0.5	0.48	96.0
2	2.0	1.94	97.0

Notes and references

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