Supplementary Information

Novel magnetic nickel telluride nanowires decorated with thorn: Synthesis and their intrinsic peroxidase-like activity for detection of glucose

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Experimental section

Chemicals

Acetic acid (99.8%), L(+)-ascorbic acid (99%), dopamine (99%), D-fructose (99%), α-lactose (99%), maltose (99%), β-D-glucose (99%), hydrazine monohydrate (80%), hydrogen peroxide (35%), sodium acetate trihydrate (99%), monosodium phosphate monohydrate (99%) and disodium phosphate heptahydrate (99%) were purchased from Sinopharm Chemical Reagent (China). ABTS (99.8%), GO_x, sodium tellurite (98%) and nickel telluride (99.9%) were purchased from Sigma Aldrich. Ultrapure water was obtained using a Milli-Q ultrapure (18.2 MΩ-cm) system.

Synthesis of NiTe TNWs

$NiCl_2$ (50 mM) was dissolved in 50 ml deionized water. Then, Na_2TeO_3 (50 mM) and 20 ml N_2H_4 was added in turn. Finally the solution was put into a 100 ml Teflon-lined autoclave which sealed and heated at 140 °C for ~6 h.

Characterization

Field-emission scanning electron microscopy (FESEM; FEI Sirion-200) and transmission electron microscopy (TEM; JEM-2010) equipped with an energy dispersive (EDS) system were used to analyze shapes and measure sizes of the NiTe samples. X-Ray scattering patterns were conducted by analyzing the samples on a Philips X-Pert Pro X-ray diffractometer (XRD, Philips X'pert PRO) with Cu Ka radiation ($\lambda_{k\alpha 1}$=1.5418 Å). The magnetic property was investigated by a vibrating sample magnetometer (VSM) with an applied field between -85000 and 85000 Oe (BHV-55, Riken, Japan). UV–vis absorption spectra of NiTe TNWs and commercial

NiTe powder were collected on a UV-2550 spectrophotometer.

Detection of H_2O_2

Briefly, ABTS (60 mM, 24 μl), NiTe TNWs or commercial NiTe powder (2.0 mg/ml, 10 μl) and H_2O_2 (0.1–500 μM) were added into an acetate buffer solution (0.2 M, pH 4.0, 185 μl). The mixture was incubated at 30 ºC for 10 min, then, NiTe TNWs were removed through centrifugation. The supernatant was diluted prior to absorption measurement. We also investigated the control experiments of the influence of incubation temperature, pH and kinds of solvent on the catalytic activity of NiTe, respectively.

Detection of Glucose

Phosphate buffered saline (PBS, 10 mM, pH 7.0, 220 μl) solutions containing glucose (1~ 500 μM) and GO_x (6 μM) were incubated at 37 °C for 30 min. ABTS (60 mM, 24 μl), NiTe TNWs stock solution (10 μl) and acetate buffer (0.2 M, pH 4.0, 800 μl) were added into the above solution. Then, the similar steps are repeated as ones in the detection of H_2O_2. To study the specificity, 5 mM maltose, fructose, lactose, dopamine and ascorbic acid instead of glucose were used as controls.

Chemical reaction process of NiTe NWs

According to the observation of phenomenon, the chemical reaction of NiTe NWs can be formulated as the following equations:

$$Ni^{2+} + TeO_3^{2-} \rightarrow NiTeO_3 \downarrow \quad \text{(S1)}$$

$$2NiTeO_3 + 3N_2H_4 \xrightarrow{140°C,10h} 2Ni + 2Te + 3N_2 \uparrow + 6H_2O \quad \text{(S2)}$$

$$Ni + Te \xrightarrow{140°C,10h} NiTe \quad \text{(S3)}$$

In the initial stage, TeO_3^{2-} reacts with Ni^{2+} to form $NiTeO_3$ precipitates. (Eqn (S1)) When N_2H_4 is added, $NiTeO_3$ precipitation is dissolved by the formation of Ni^{2+}-N_2H_4 complex ion and dissociative TeO_3^{2-} is formed again. At 140 °C, TeO_3^{2-} and Ni^{2+} can easily be reduced by hydrazine to Te and Ni (Eqn (S2)). These Te and Ni are highly reactive enough to react with each other to form the NiTe monomer (Eqn (S3)). With the time aging, these monomers will grow quickly along the predominant direction to form nanowires.

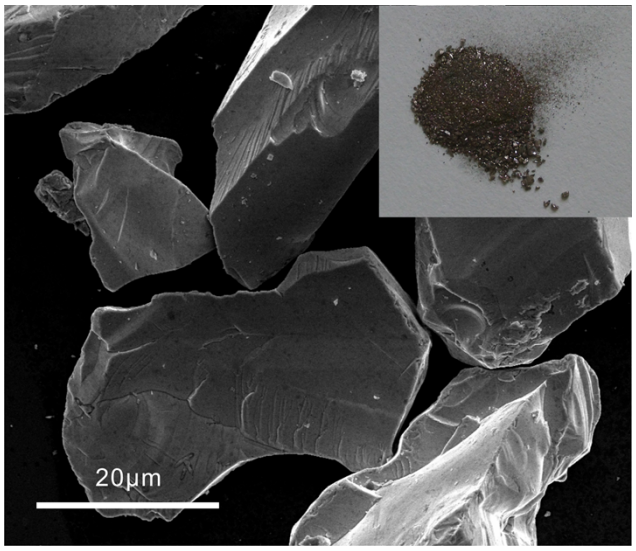

Fig. S1 SEM image of the commercial NiTe sample. Inset is photograph of the commercial NiTe sample.

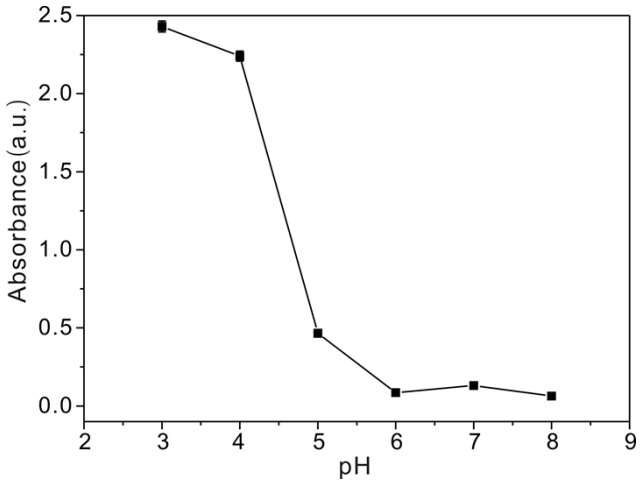

Fig. S2 Effects of pH on the catalytic activity of the NiTe TNWs for H_2O_2-mediated ABTS reaction.

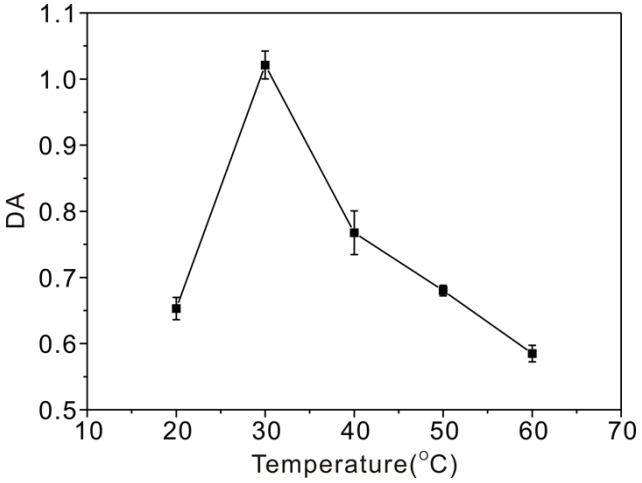

Fig. S3 Effects of temperature on the catalytic activity of the NiTe TNWs for H_2O_2-mediated ABTS reaction. DA against temperature, where DA = $A_{418\ nm}$ (NiTe TNWs)– $A_{418\ nm}$ (Blank). Other conditions are the same as in Fig. 3.

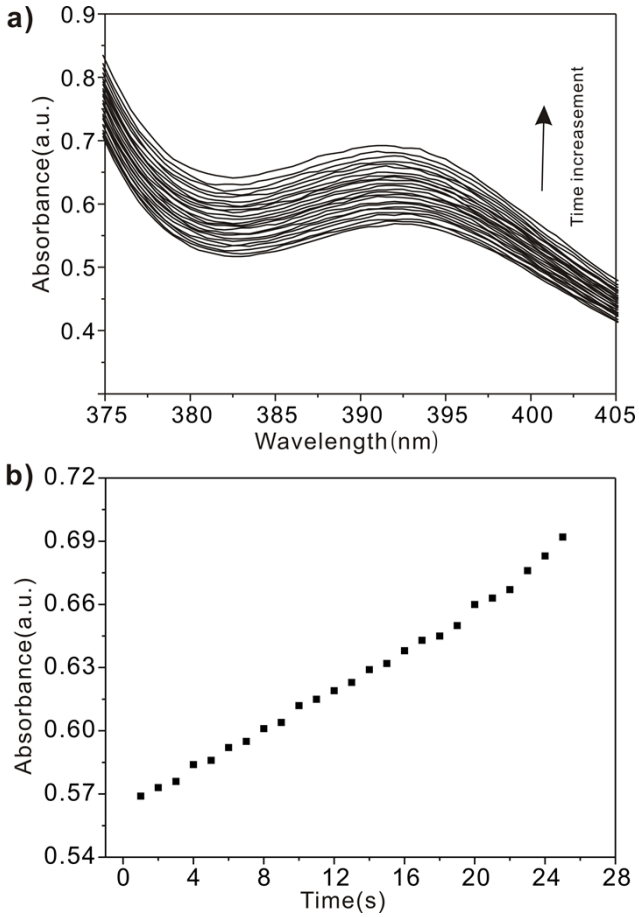

Fig. S4 a) Time-dependent UV–Vis absorption spectra and b) Michaelis-Menten kinetics of ABTS oxidation catalyzed by NiTe TNWs in acetonitrile organic solvents. The maximal absorbance at 396 nm is monitored with time interval 1min.

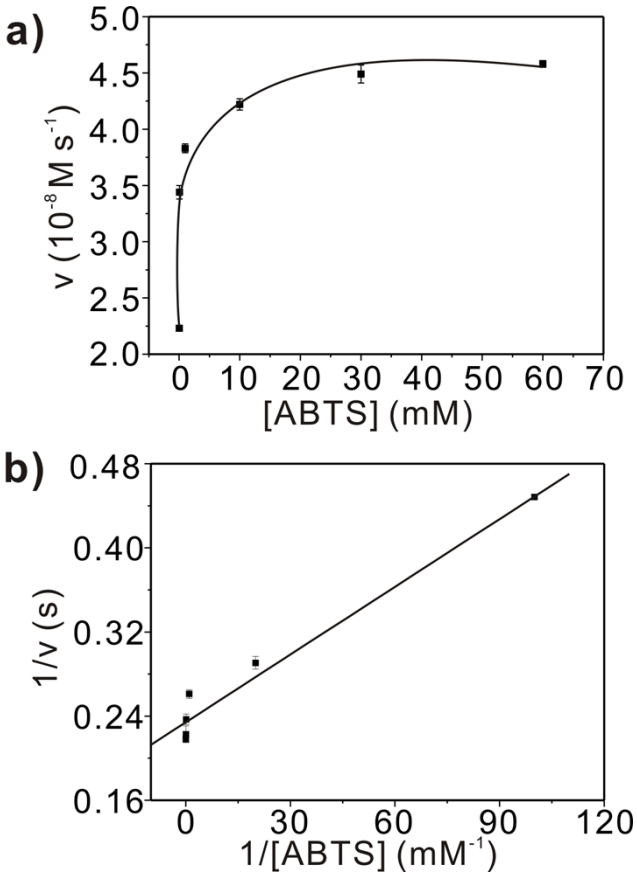

Fig. S5 a) The reaction rate and b) double-reciprocal plot of activities of NiTe TNWs in the presence of 0.1 M H_2O_2 and ABTS with different concentrations at room temperature.

Fig.S5 shows the kinetic assay of NiTe TNWs. Kinetic experiments measurements were carried out in time course mode by monitoring the absorbance change at 418 nm using the UV-vis spectrophotometer. The Michaelis-Menten constant was calculated from Lineweaver-Burk plot of the double-reciprocal form of the Michaelis–Menten equation [Eqn. (S1)]:

$$1/v = (K_m / V_{max})(1/[s]) + 1/V_{max} \quad \text{(S1)}$$

where v is the initial velocity, V_{max} represents the maximal reaction velocity, and [s] is the substrate concentration. K_m is the Michaelis−Menten constant.

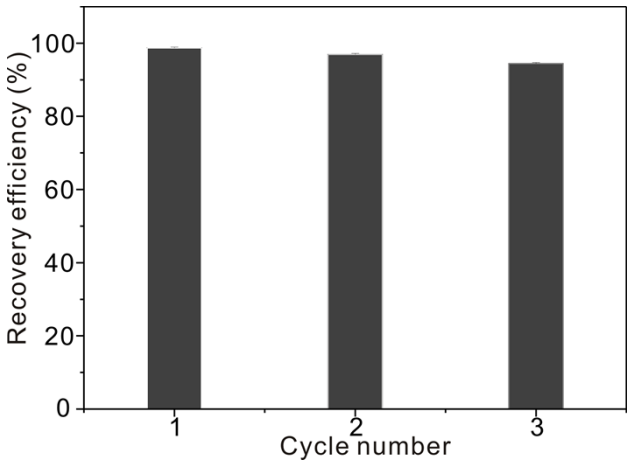

Fig. S6 Recovery efficiency of NiTe TNWs for the peroxidase-like catalytic reaction for different cycle numbers. Recovery efficiency is defined as $A_{cycle\ number}/A_{initial}$, where $A_{initial}$ and $A_{cycle\ number}$ are the absorbance (λ=418 nm) of 500 μm glucose at the initial and different cycle numbers, respectively. $A_{initial}$=0.707.

Fig. S6 shows that the recovery efficiency still retained about 95% of the initial value after three cycles, which suggests the acceptable recyclability of NiTe TNWs for the peroxidase-like catalytic reaction.

Table S1

Michaelis constant (K_m) and maximal reaction rate (V_{max}) of NiTe TNWs and HRP.

	K_m (mM)	V_{max} (10^{-8} M s^{-1})
NiTe TNWs	0.011	4.27
Co_3O_4 NPs[1]	0.037	3.20
HRP[2]	0.062	3.61

1 W.J. Qin, L. Su, C. Yang, Y.H. Ma, H.J. Zhang and X.G. Chen, *J. Agric. Food Chem.*, 2014, **62**, 5827.

2 X.L. Sun, S.J. Guo, C.S. Chung, W.L. Zhu and S.H. Sun, *Adv. Mater.*, 2013, **25**, 132.