Electronic Supplementary Material (ESI) for Nanoscale

Supplementary Information

In situ growth, structure characterization, and enhanced photocatalysis of high-quality, single-crystalline ZnTe/ZnO branched nanoheterostructures

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1. Morphology of ZnTe/ZnO nanoheterostructures fabricated in tube furnace

The branched ZnTe/ZnO nanoheterostructure can be achieved not only in environmental scanning electron microscopy but also in the tube furnace with large-scale. The ZnTe nanowires were firstly synthesized in a furnace tube via vapour phase transport method, the experimental details could be found in “Sample synthesis” section. Subsequently, a second step to grow the ZnO nanowires on the ZnTe nanowires was also carried out in tube furnace. 0.2 g Zn powder in a quartz tube and ZnTe sample 2 cm downstream away from the quartz tube were placed in a furnace tube. The source material was heated at

700 °C for 5 mins with with 100 sccm Ar and 8 sccm O_2, and working pressure was kept at 10 Pa. The final morphology of ZnTe/ZnO nanoheterostructure fabricated in tube furnace was demonstrated in Fig. S1.

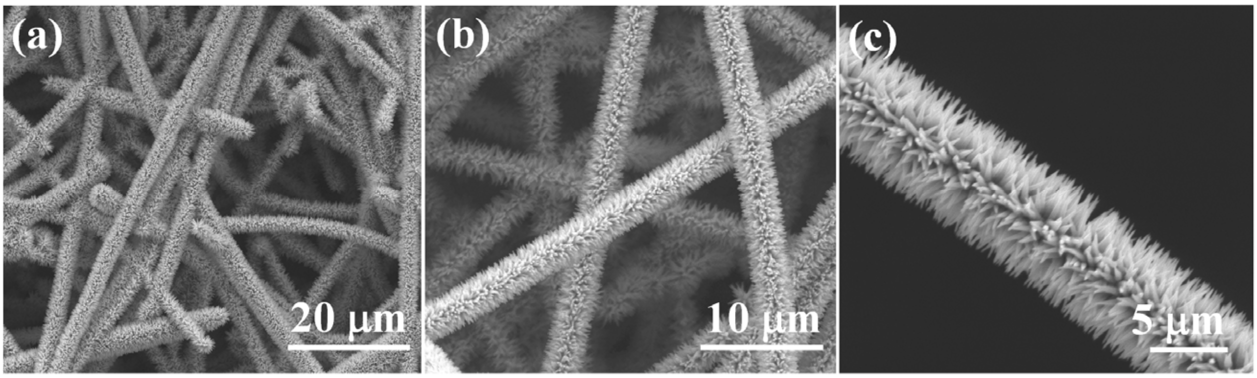

Fig. S1 SEM image of typical morphology of ZnTe/ZnO nanoheterostructures fabricated in tube furnace with large yield.

2. Discussion of interplanar distances mismatch at the interface of ZnO/ZnTe nanoheterostructure

Fig. S2(a) shows high resolution TEM (HRTEM) image of the ZnTe/ZnO interface, which clearly indicate that the growth direction of ZnTe is [111], with clear lattice fringes of ZnO (101) planes, suggesting that good single-crystalline ZnO nanowire was heteroepitaxially grown on the surface of ZnTe nanowire. Noticeably, we found that the atoms of ZnO (101) planes were not perpendicularly arranged along the ZnTe [111] direction. The angel between the ZnO (101) planes and ZnTe (111) planes was about 37.8^{o}. The connection between $(101)_{ZnO}$ and $(111)_{ZnTe}$ lattices at the interface of the branched ZnTe/ZnO nanoheterostructure is illustrated schematically in the Fig. S2(b). When $(101)_{ZnO}$ grows perpendicularly to the surface of the ZnTe nanowire, the interfacial lattice mismatch between $(101)_{ZnO}$ and $(111)_{ZnTe}$ reaches as large as 28.5%

((0.35-0.25)/0.35 × 100% = 28.5%). However, when $(101)_{ZnO}$ grows slantwise, the interfacial lattice mismatch is dramatically reduced to 14.2% ((0.4-0.35)/0.35 × 100% = 14.2%). The reduced lattice mismatch at the interface leads to the reduced lattice distortion energy and decreased the heteronucleation energy barrier, which determined the slantwise $(101)_{ZnO}$ growth at the interface of $(111)_{ZnTe}$.

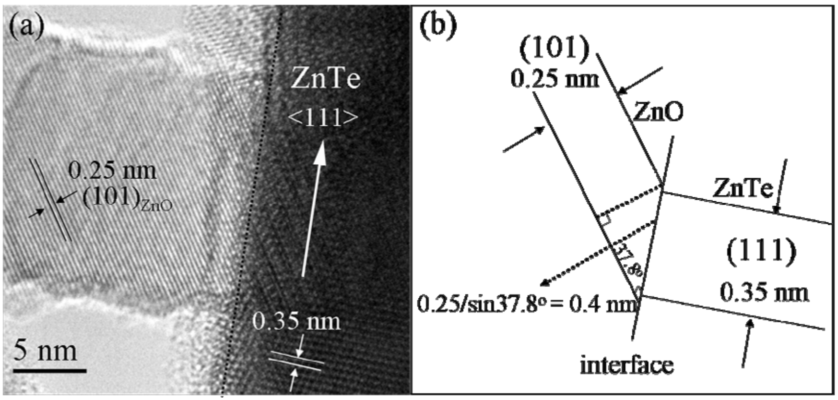

Fig. S2 (a) HRTEM image of interfacial region in a ZnTe/ZnO nanoheterostructure, revealing single-crystalline ZnO was grown on the ZnTe nanowire with high quality. (b) Schematic diagrams illustrated the connection between $(101)_{ZnO}$ and $(111)_{ZnTe}$ lattices at the interfacial region.

3. Transmission spectra of the branched ZnTe/ZnO nanoheterostructures

The transmission spectra of the branched ZnTe/ZnO nanoheterostructures, pure ZnO nanowires and ZnTe nanowire were shown in Fig. S3. Transmission from the pure ZnO nanowires below 380 nm is very low, reaching almost zero, but increases significantly after 380 nm, indicating that their light absorption ability only exhibits in the UV range. Pure ZnTe nanowires have a fairly low light absorption with the large transmission over the range from 300~800 nm. The branched ZnTe/ZnO nanoheterostructures demonstrate significantly increased light adsorption in the wide range from UV to visible (300~800 nm) with very low transmission (< 12%). Compared with pure ZnTe nanowires, branched ZnTe/ZnO nanoheterostructures significantly decreased the light transmission from ~30% to ~8% in the measurement range, indicating strong ability to enhance the light absorption. The enhanced light absorption in the UV-visible range reveals that the branched ZnTe/ZnO nanoheterostructures have a great advantage in photocatalysis.

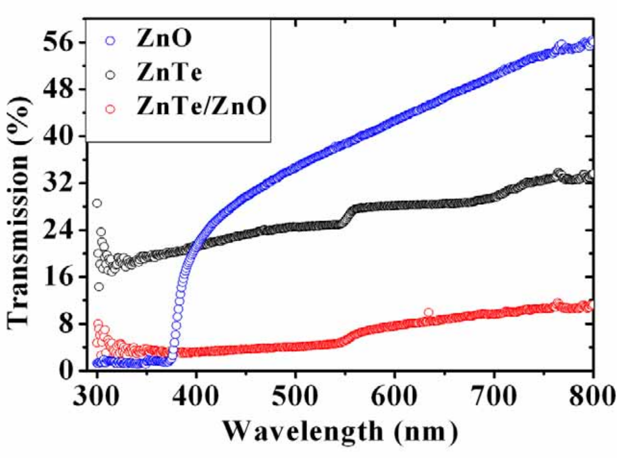

Fig. S3 Transmission spectra of ZnO nanowires, ZnTe nanowires and ZnTe/ZnO nanoheterostructures.