Microsphere Assembly of TiO_2 with Tube-in-Tube Nanostructures : Anisotropic Etching and Photovoltaic Enhancement

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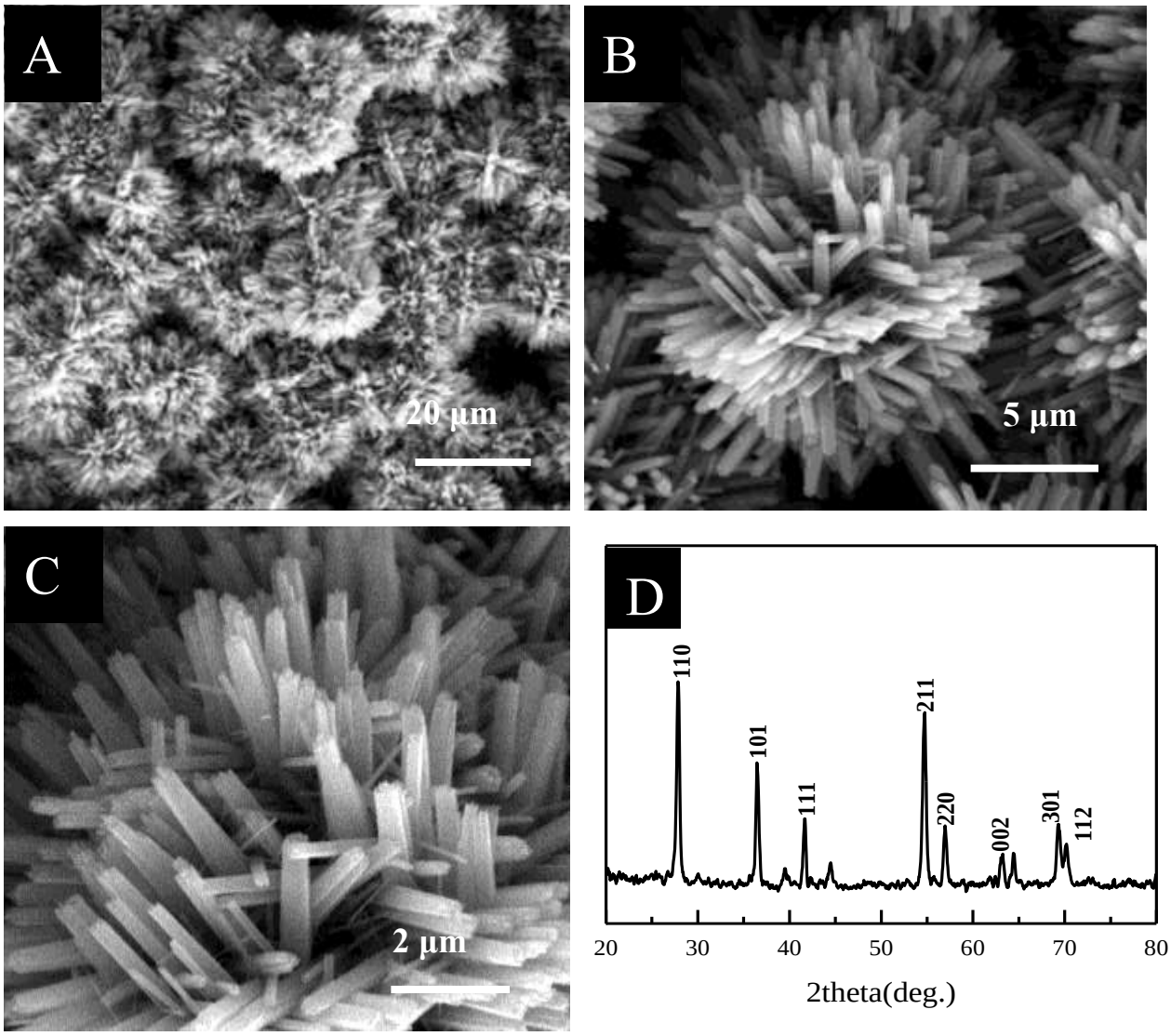

Figure S1. (A) A SEM image showing the overview of the TiO_2 microsphere (R) sample. (B) A SEM image of an individual TiO_2 microsphere. (C) A magnified SEM image showing the surface of the microsphere. (D) XRD patterns of the TiO_2 microsphere (R) sample.

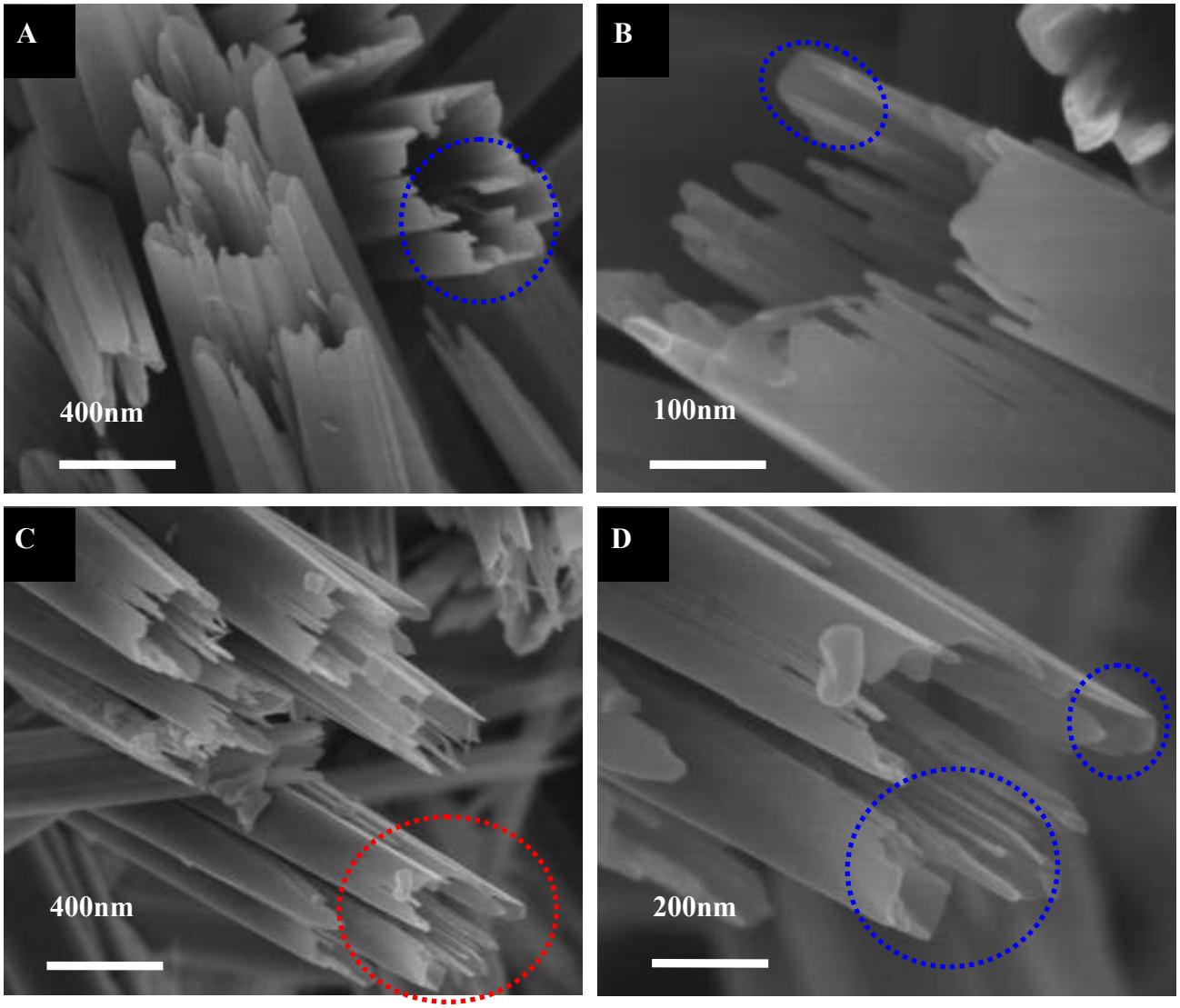

Figure S2. (A-D) FESEM images emphasizing the tubular structures of the TiO_2 microsphere (T) sample. Blues dashed circles in (A, B, and C) indicate that the wall of these nanotubes also have tubular structures, the so-called tube-in-tube structures. (D) magnified images of the region in red dashed circle in (C).

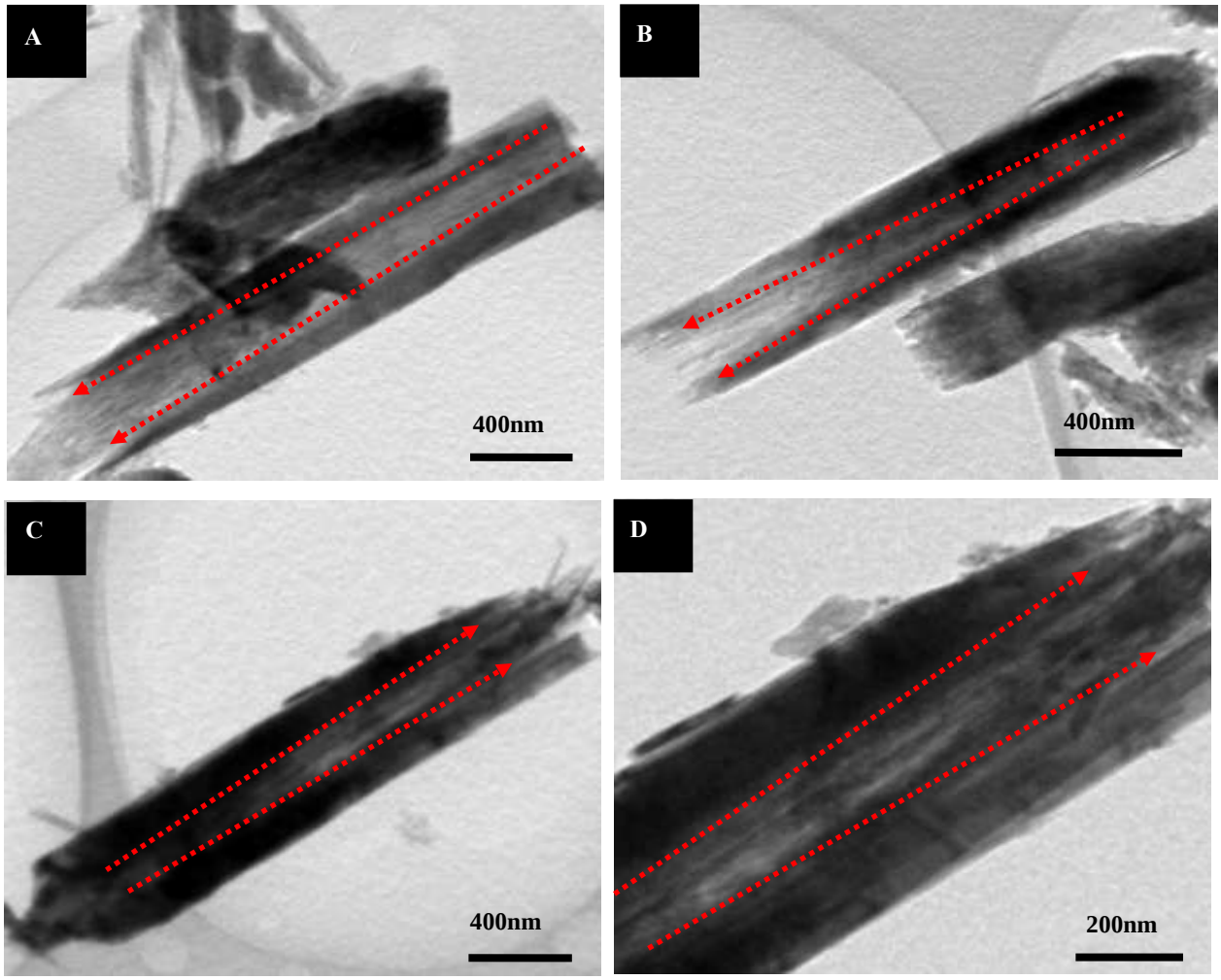

Figure S3. (A, B, and C) TEM images of TiO_2 nanotubes. (D) A magnified TEM image of the same nanotube as shown in (C). Red dashed lines in all images illustrate the V-shaped spaces inside the nanotubes, while the arrows point to the open ends of the nanotubes.

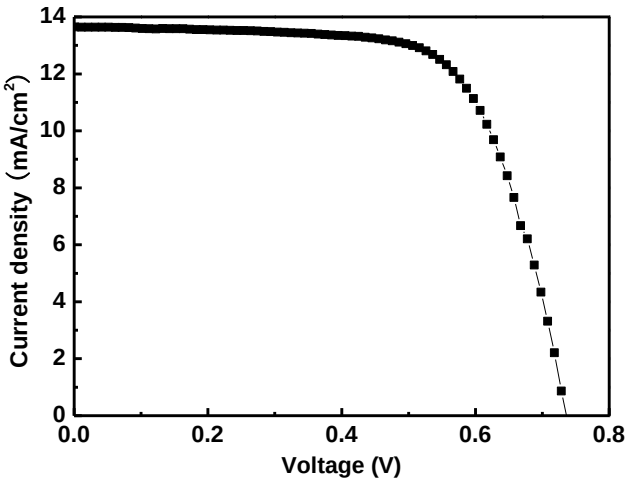

Figure S4. Characteristic photocurrent-voltage (IV) curves of dye-sensitized solar cells assembled by using the TiO_2 nanorod as the middle layer of the sandwiched photoanode (DSSC-R).

We make an addition work that replaces the middle layer of tubular TiO_2 with TiO_2 nanorod and get a J_{sc} = 13.64 mA/cm^2, V_{oc} = 0.74 V, FF = 0.68 and η =6.86 %. The conversion efficiency is lower than that of DSSC-2 using TiO_2 nanotube as sandwiched layer.