

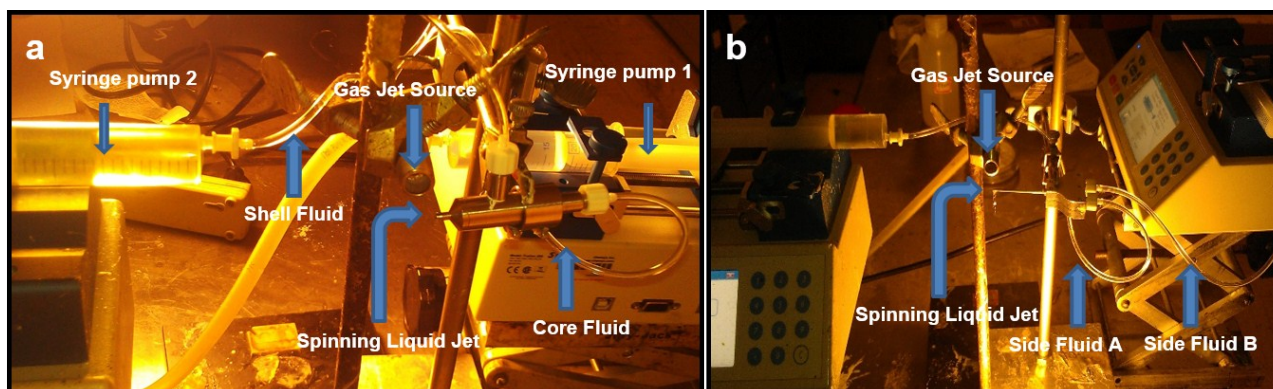
## Supporting Information

### Bi-component inorganic oxide nanofibers from Gas Jet Fiber spinning process

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#### Experimental Procedure:

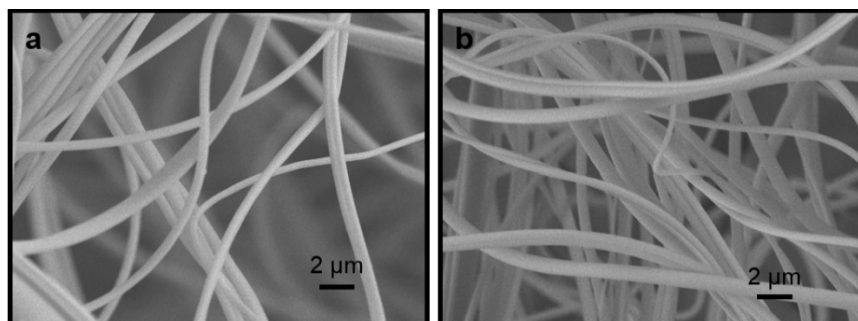
A combined sol-gel chemistry and Gas Jet Fiber (GJF) spinning is utilized to fabricate single component titanium dioxide (TiO<sub>2</sub>) and tin doped indium oxide (ITO), and bi-component core-shell (CS) and side-by-side (SBS) ITO-TiO<sub>2</sub> nanofibers.



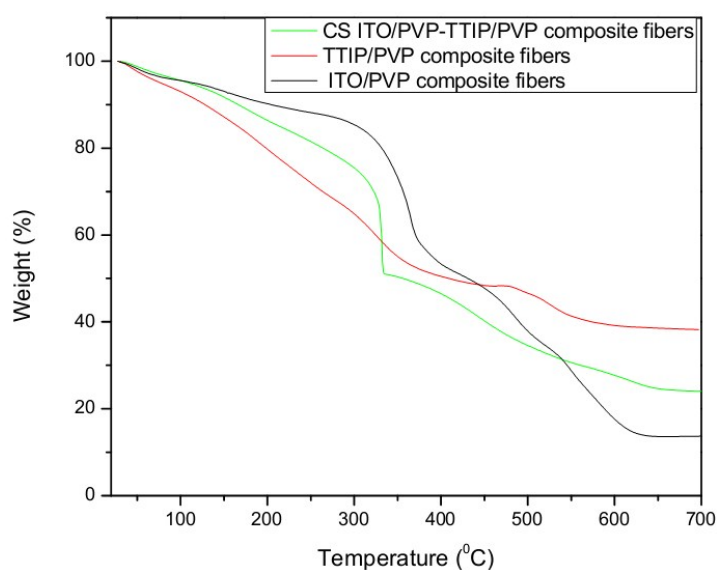
**Fig. S1** Digital images of the arrangement of (a) core-shell (CS), and (b) side-by-side (SBS) GJF spinning process for fabrication of bi-component ITO-TiO<sub>2</sub> nanofibers.

Needle-tip GJF spinning is carried out to prepare nanofibers from each of the solutions used in the side-by-side and core-shell spinneret to set-up conditions under which each solution is independently capable of producing good quality nanofibers. Under the studied spinning conditions, e.g. needle of internal diameter of 0.89 mm, applied air pressure of 20 psi, a fixed collection distance of 180 cm, and a flow rate of 0.3 mL min<sup>-1</sup>, ambient temperature 25-27 °C, and relative humidity of 30-35%, the resultant nanofibers of TiO<sub>2</sub> and ITO after heat treatment at 700 °C with a heating rate of 0.5 °C min<sup>-1</sup> shows an average diameter of 217±82 nm (Fig. S4(a)) and 130±41 nm (Fig. S4(b)), respectively. Successful fabrication strategy of single component TiO<sub>2</sub> and ITO nanofibers from needle tip GJF spinning process is adopted to design bi-component (ITO and TiO<sub>2</sub>) nanofibers of CS and SBS morphologies.

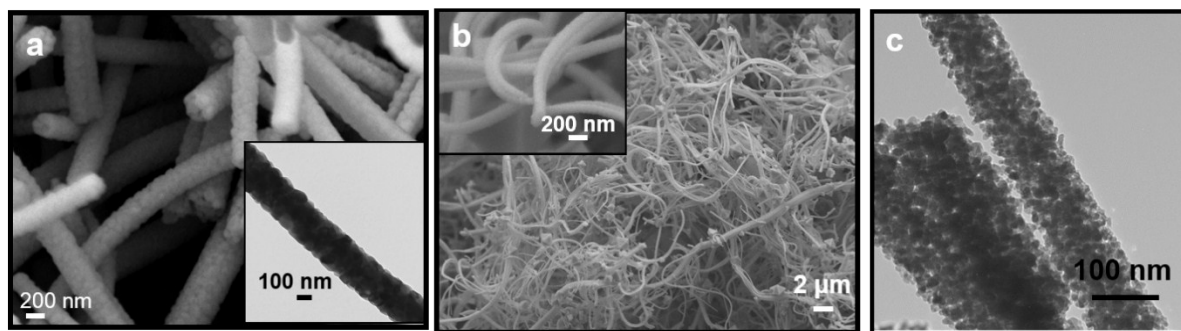
The composite PVP-ITO and PVP-TiO<sub>2</sub> fibers are of smooth cylindrical form (see Fig. S2(a) and S2(b)) having a distribution of diameter in the range of ~300-1500 and ~200-900 nm. The fibers shrink in diameter after calcination due to loss of polymer and their surface became rough. Fig. S4 shows SEM micrographs of as-prepared TiO<sub>2</sub> and ITO fibers after calcining at 700 °C for 2 h in air. A cylindrical structure of ITO with a diameter distribution in the range of ~50-650 nm (see Fig. S4(b) and Fig. S5(c)) is obtained after calcination at 700 °C. The solid cylindrical morphology of ITO fibers is further confirmed by transmission electron microscopy (TEM) (see Fig. S4(c)). High magnification TEM image in Fig. S4(c) reveals that the surface of the ITO nanofibers are comprised of interconnected ITO nanocrystals with an average size of about 15-30 nm. On the other hand, TiO<sub>2</sub> nanofibers have a diameter distribution in the range of ~50-350 nm at a calcination temperature of 700 °C (see Fig. S5(b)). A single TiO<sub>2</sub> nanofiber consists of nanocrystals of TiO<sub>2</sub> with a size range of 20-60 nm as shown in TEM micrograph in Fig. S4(a).



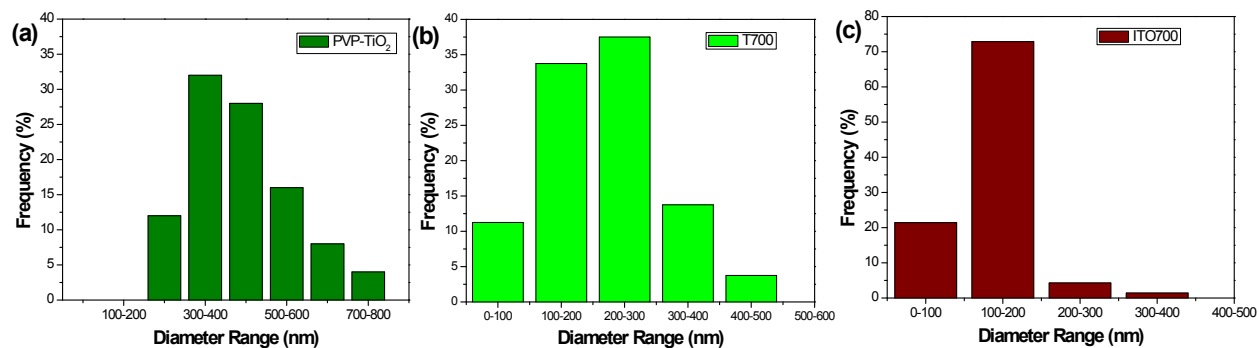
**Fig. S2** SEM images of precursor fibers fabricated by needle tip GJF-spinning of each of the two solutions used to produce bi-component nanofibers: (a) nanofibers of PVP-ITO and (b) nanofibers of PVP-TiO<sub>2</sub>. Spinning condition: air pressure= 20 psi, flow rate= 0.3 mL min<sup>-1</sup>, needle ID= 0.89 mm, RH= 36% and T= 24 °C.



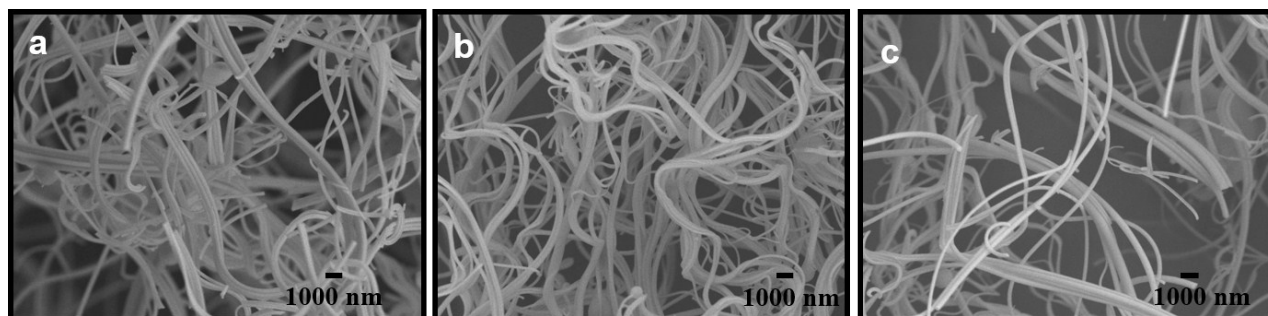
**Fig. S3** TGA trace of thermal decomposition of as spun PVP-ITO, PVP-TiO<sub>2</sub>, and CS PVP/ITO-PVP/TiO<sub>2</sub> precursor fibers carried out at a heating rate of 10 °C min<sup>-1</sup> from room temperature to 700 °C using air flow of 60 mL min<sup>-1</sup>.



**Fig. S4** SEM images of calcined nanofibers produced from needle tip GJF spinning process (a) nanofibers of TiO<sub>2</sub> (inset: TEM image of corresponding TiO<sub>2</sub> fiber), (b) nanofibers of ITO calcined at 700 °C with 0.5 °C min<sup>-1</sup> (inset: High magnification SEM image of corresponding ITO fiber), and (c) TEM image of corresponding ITO nanofibers. Spinning condition: air pressure= 20 psi, flow rate= 0.3 mL min<sup>-1</sup>, needle ID= 0.89 mm, RH= 30%, and T= 25 °C.



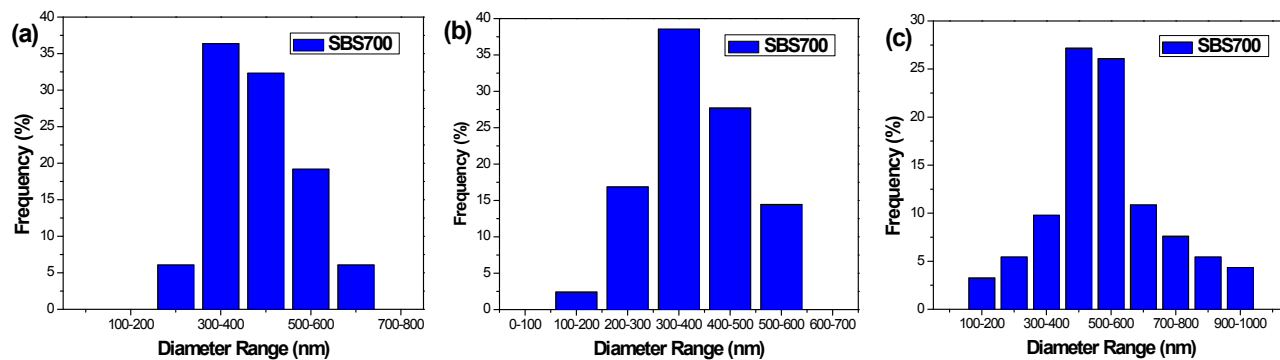
**Fig. S5** Diameter distribution of nanofibers produced from needle tip GJF spinning process (a) Precursor PVP-TiO<sub>2</sub> nanofibers, (b) nanofibers of corresponding TiO<sub>2</sub> calcined at 700 °C (T700), and (c) nanofibers of ITO calcined at 700 °C (ITO700).



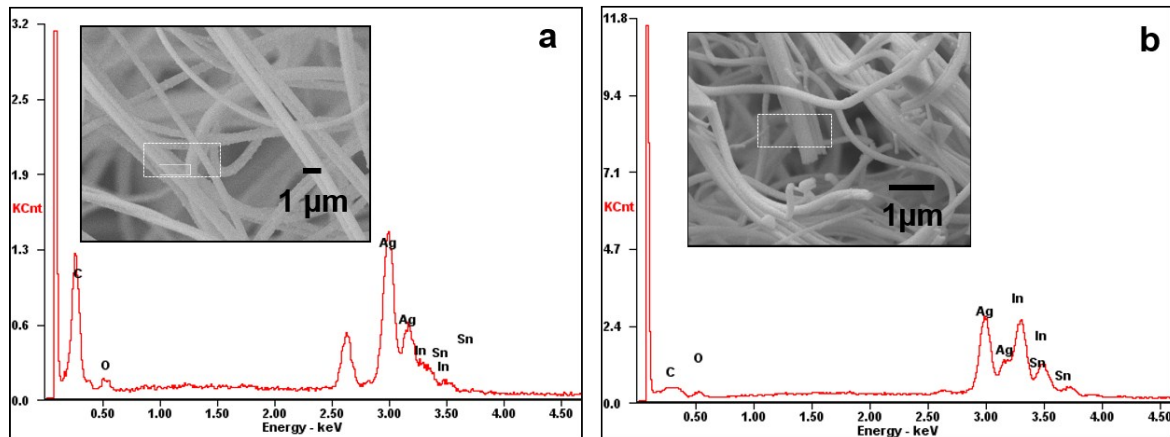
**Fig. S6** Effect of flow rate (a) 0.1, (b) 0.2, and (c) 0.3 mL min<sup>-1</sup> on morphology and diameter of side-by-side spinning derived SBS700 fibers. Spinning condition: Air pressure = 20 psi, Needle ID = 0.89 mm, RH = 36%, and T = 24 °C, Calcination: 700 °C for 2 h with 0.5 °C min<sup>-1</sup>.

**Table S1.** Effect of flow rate on diameter of side-by-side fibers

GJF Spun Fibers of SBS morphology	Flow rate of spinning solutions (mL min <sup>-1</sup> )		
	0.1	0.2	0.3
Size before calcination (nm)	938±190	873±221	981±276
Size after calcination at 700 °C with 0.5 °C min <sup>-1</sup> (nm)	415±83	366±92	519±152



**Fig. S7** Diameter distribution of side-by-side ITO-TiO<sub>2</sub> nanofibers calcined at 700 °C (SBS700) produced from GJF spinning process with different solution flow rate (a) 0.1, (b) 0.2, and (c) 0.3 mL min<sup>-1</sup>.



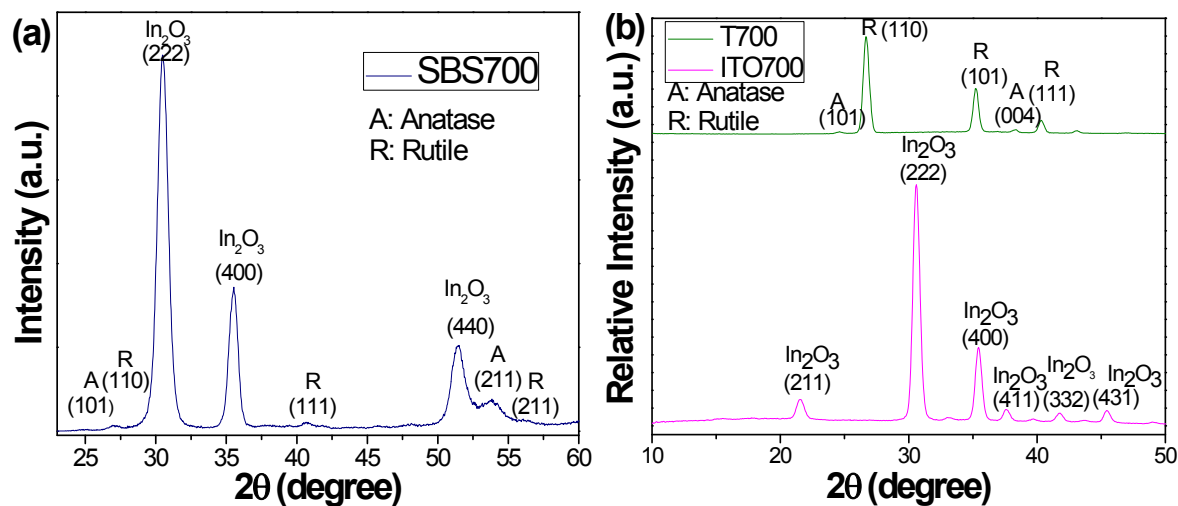
**Fig. S8** EDS Pattern of (a) precursor ITO-PVP fibers, and (b) corresponding ITO nanofibers calcined at 700 °C with a heating rate of 0.5 °C min<sup>-1</sup>.

**Table S2.** Elemental composition of precursor ITO-PVP and ITO fibers

Element	ITO-PVP	ITO
	At%	At%
C	70.34	24.28
O	10.69	19.05
Ag	16.25	27.05
In	02.23	28.43
Sn	00.49	01.18

**X-ray diffraction (XRD) analysis:**

The pattern exhibits diffraction peaks of (211), (222), (400), (411), (332), and (431) planes (Fig. S9(b)), corresponding to the body-centered cubic phase of In<sub>2</sub>O<sub>3</sub> (JCPDS file no. 06-0416), and no other phase related to tin compounds is detected.



**Fig. S9** WAXD patterns of the (a) side-by-side spun ITO-TiO<sub>2</sub> nanofibers calcined at 700 °C, and (b) single component TiO<sub>2</sub> and ITO fibers calcined at 700 °C from needle tip GJF spinning process.