Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Fabrication of Silica/Titania Hollow Nanorod and Its Electroresponsive Activity

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Fig. S1

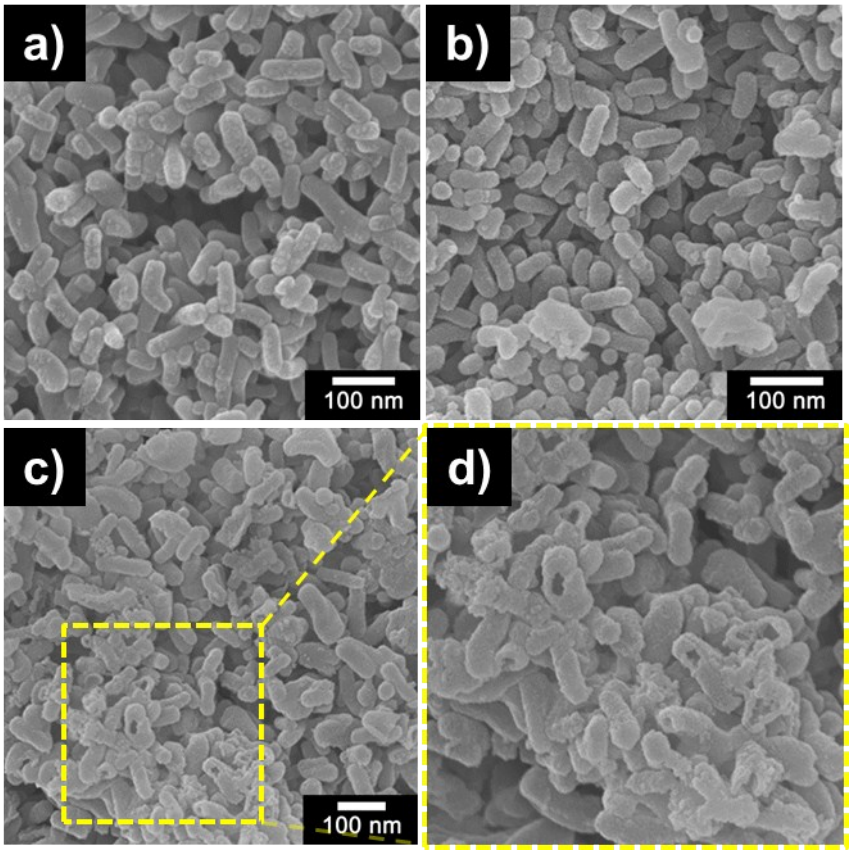

Fig. S1 SEM micrographs of a) SiO_2 rod, b) ST/CS rod, and c) HST rod (*L/D* = 3), respectively. d) Observation of internal hollow space from ruptured part of HST rod.

Fig. S2

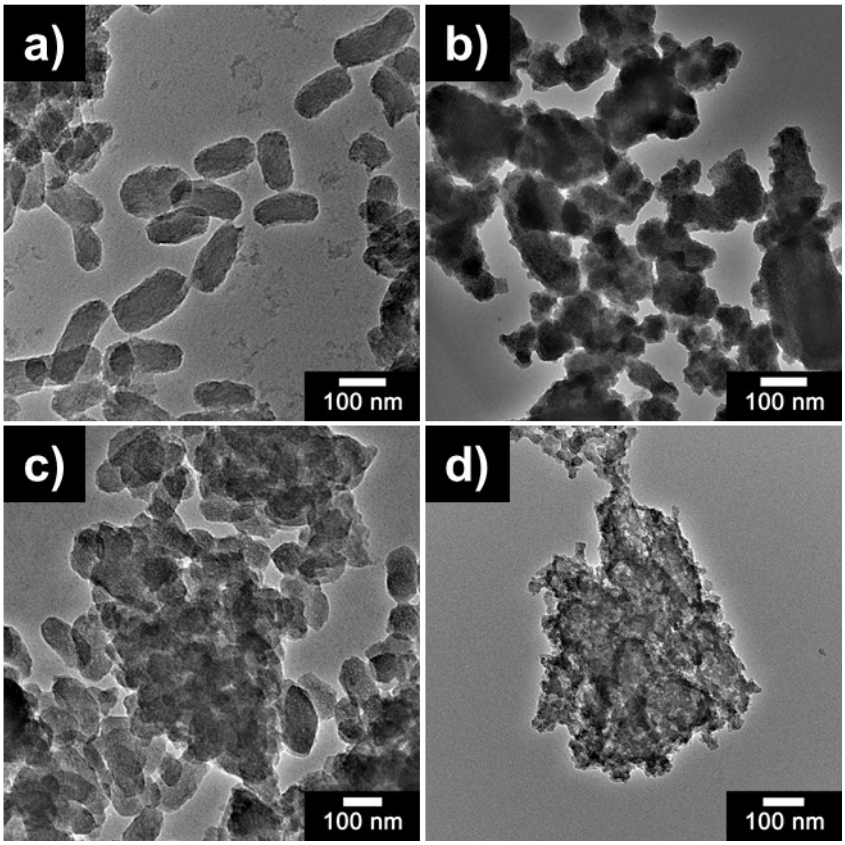

Fig. S2 TEM micrographs of a) HCl untreated SiO_2 rod, b) HST rod from HCl untreated SiO_2 rod, c) calcined SiO_2 rod, and d) HST rod from calcined SiO_2 rod.

Fig. S3

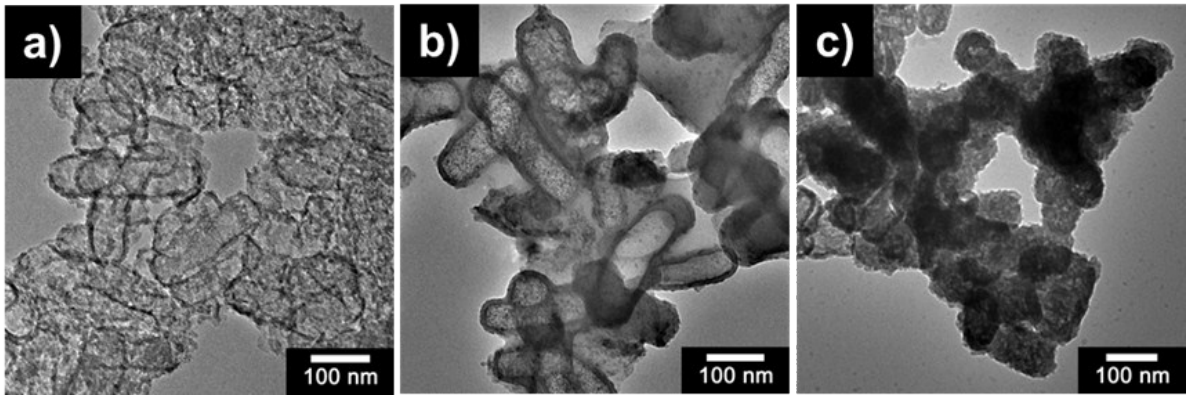

Fig. S3 TEM micrographs of various shell thickness controlled HST nanorods fabricated by adding TTIP amount of a) 6 mL, b) 12 mL, and c) 16 mL, respectively.

Fig. S4

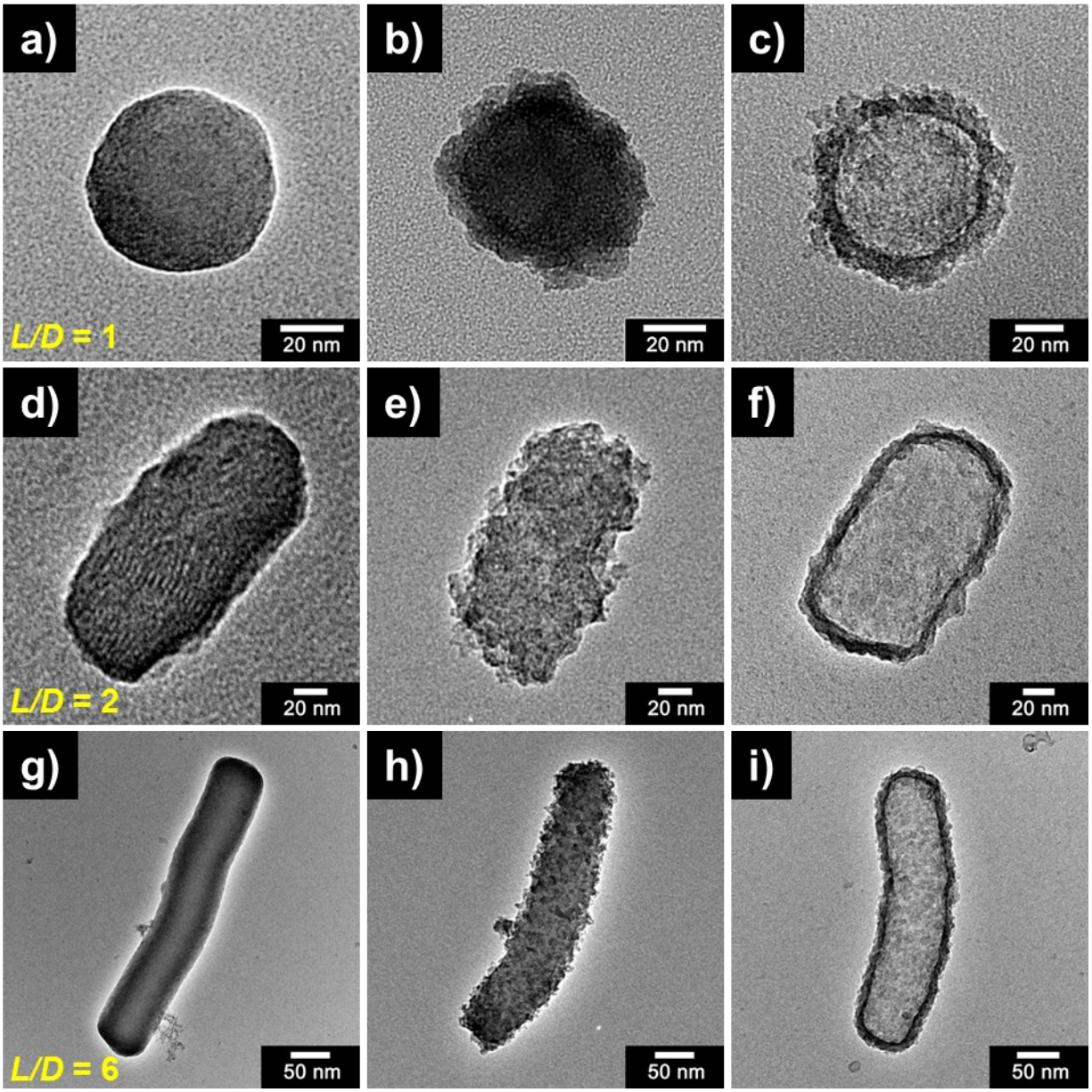

Fig. S4 TEM micrographs of SiO_2, ST/CS, and HST (left to right) (a, b, c) sphere with *L/D* = 1, (d, e, f) rod with *L/D* = 2, and (g, h, i) rod with *L/D* = 6.

Fig. S5

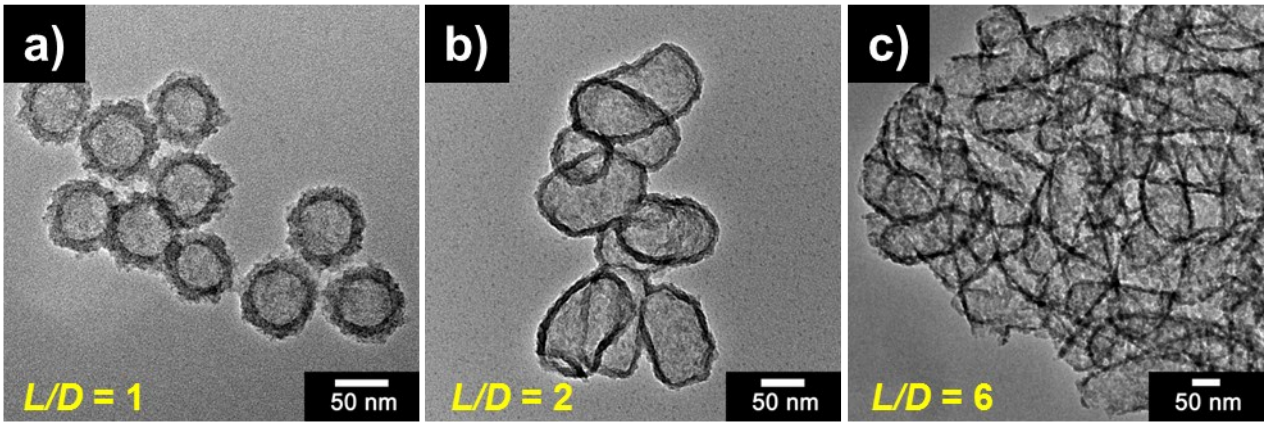

Fig. S5 Low-magnified TEM micrographs of a) HST sphere (*L/D* = 1), b) HST rod (*L/D* = 2), and HST rod (*L/D* = 6).

Table S1

Table S1 Physical parameters of various HST material fabricated by same synthetic method [a]

Shape	Length (nm)	Diameter (nm)	*L/D*	BET area (m^2g^{-1})[b]	Pore volume (cm^3g^{-1})[c]
sphere	*ca.* 75	*ca.* 75	1	435.3	0.69
rod	*ca.* 75	*ca.* 155	2	469.7	0.75
rod	*ca.* 75	*ca.* 230	3	496.8	0.87
rod	*ca.* 75	*ca.* 460	6	522.3	0.97

[a] All materials were fabricated by sequential combination of sol-gel, TiO_2 coating process, and SMER method using different sized SiO_2 core template.
[b] Calculated by BET method
[c] Pore size of pore created on the SiO_2/TiO_2 shell

Table S2

Table S2 Various physical properties of SiO_2, ST/CS rod, and HST rod (L/D = 3)

Material	BET area ($m^2\ g^{-1}$)[a]	Pore volume ($cm^3\ g^{-1}$)	Pore size (nm)[b]
SiO_2 rod	82.8	0.41	3.3
ST/CS rod	266.1	0.56	3.8
HST rod	496.8	0.87	4.0

[a] Calculated by BET method

[b] Pore size of pore created on the SiO_2/TiO_2 shell

Table S3

Table S3 Elemental compositions of SiO_2 rod, ST/CS rod, and HST rod (*L/D* = 3)[a]

	Si (atomic %)	Ti (atomic %)	O (atomic %)
SiO_2 rod	26.01	-	73.9
ST/CS rod	14.20	8.67	77.13
HST rod	10.42	10.71	78.87

[a] Elemental composition of samples were acquired by EDS mode (beam current: 10.0 μA, accelerating voltage: 10.0 kV).

Fig. S6

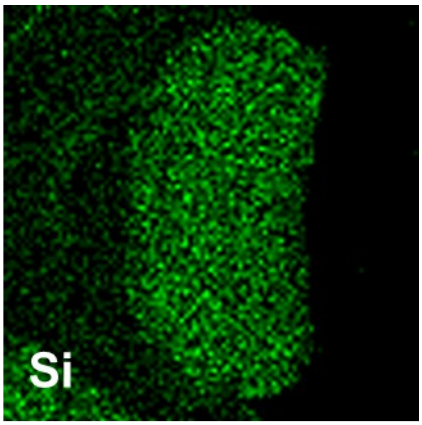

Fig. S6 STEM elemental mapping image of SiO_2 (detected element: Si).

Fig. S7

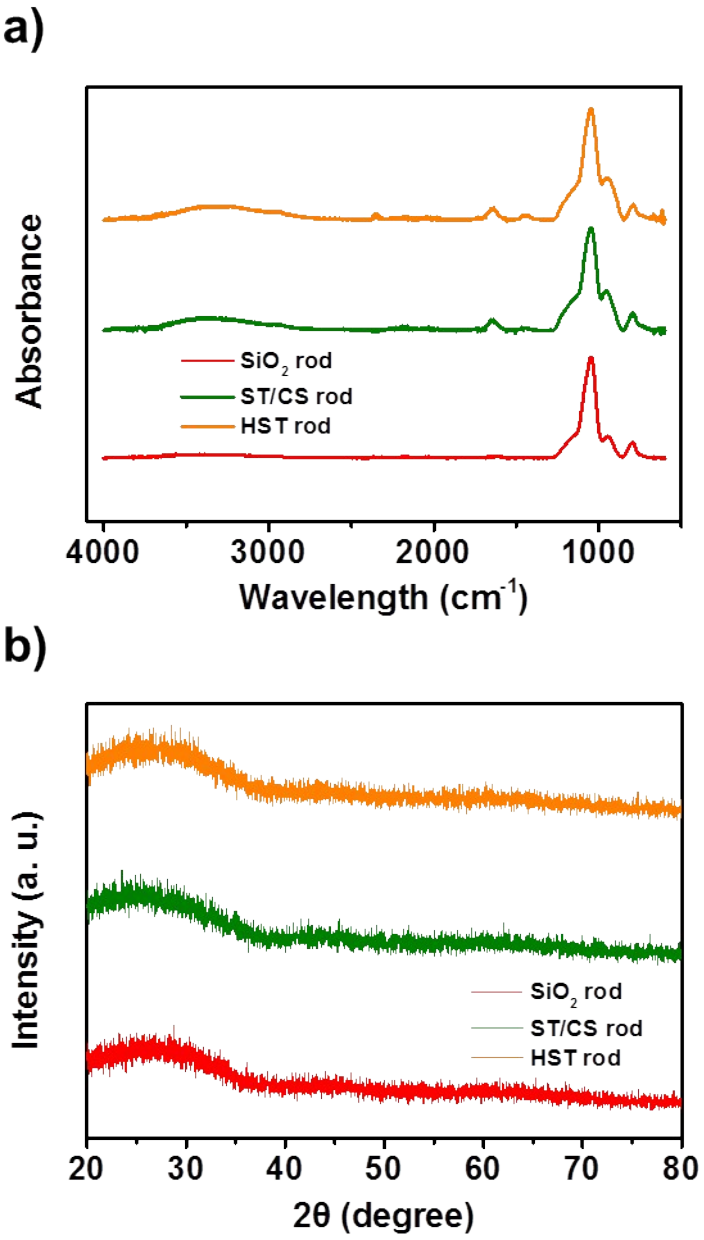

Fig. S7 a) FT-IR spectra of SiO_2 rod, ST/CS rod, and HST rod (*L/D* = 3). b) XRD diffraction patterns of SiO_2 rod, ST/CS rod, and HST rod (*L/D* = 3).

Fig. S8

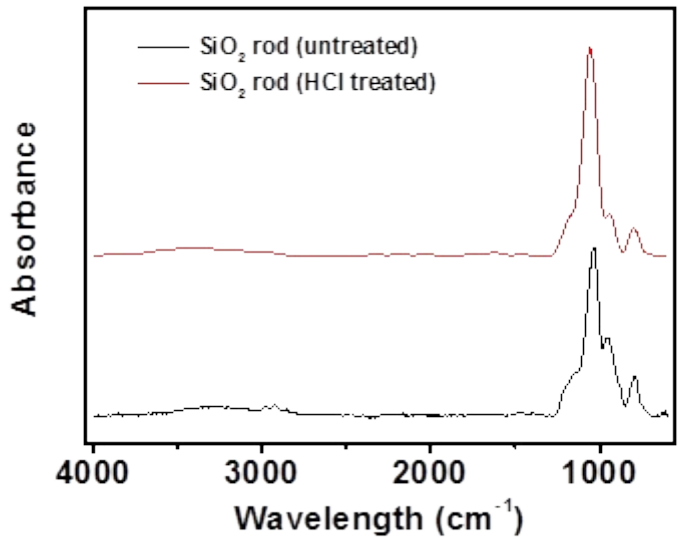

Fig. S8 FT-IR spectra of ethanolic acid washed SiO_2 rod and HCl untreated SiO_2 rod.

Table S4

Table S4 Elemental compositions of HST sphere and two HST rod (*L/D* = 2 and 6).

	Si (atomic %)	Ti (atomic %)	O (atomic %)
HST sphere (75 nm)	8.77	12.71	78.52
HST rod (*L/D* = 2)	9.23	11.92	78.85
HST rod (*L/D* = 6)	12.35	9.32	78.33

[a] Elemental composition of samples were acquired by EDS mode (beam current: 10.0 μA, accelerating voltage: 10.0 kV).

Fig. S9

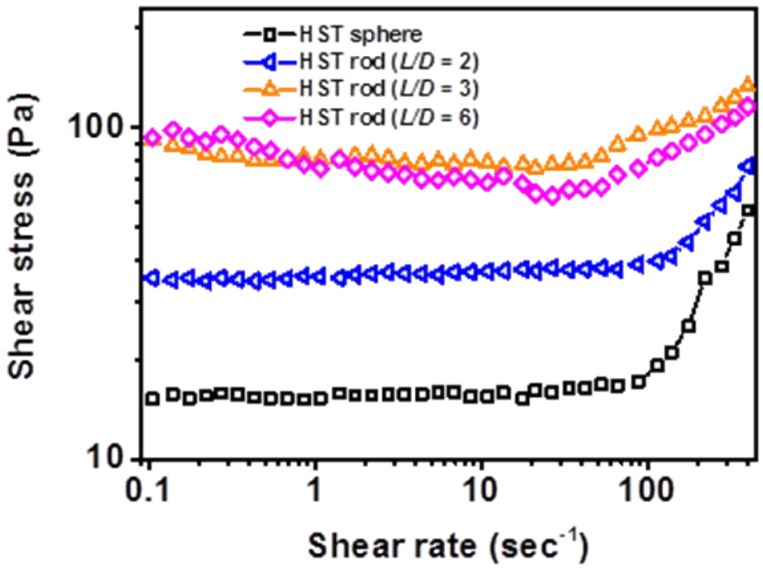

Fig. S9 Shear stress of various HST nanomaterials-based ER fluids with different aspect ratio as a function of shear rate (τ') under 3.0 kV mm^{-1} of electric field strength (3.0 wt% in silicone oil).

Fig. S10

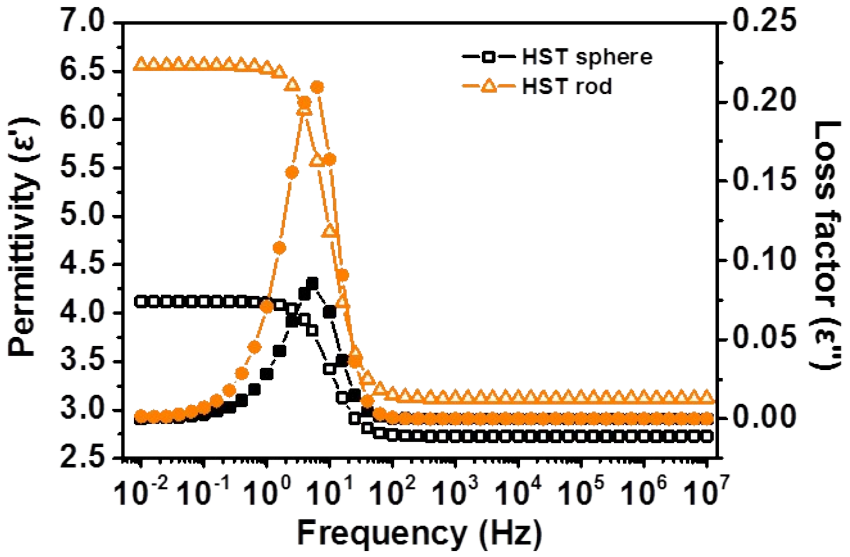

Fig. S10 Permittivity (ε', open symbol) and loss factor (ε'', closed symbol) of similarly fabricated HST sphere and HST rod as a function of electric field frequency (f).

Fig. S11

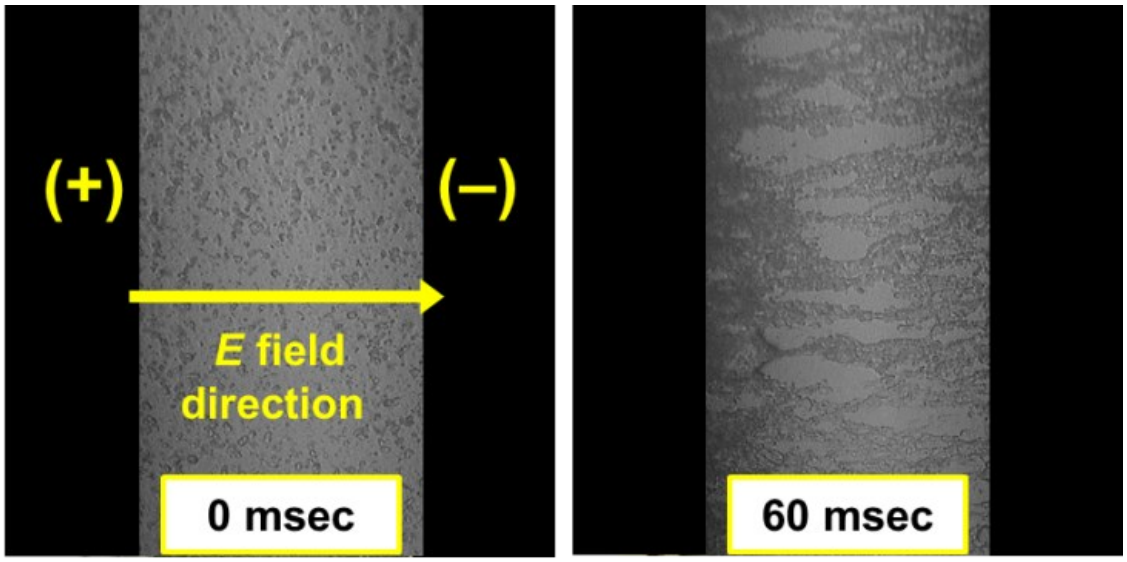

Fig. S11 Real-time optical microscope (OM) images of structural change of HST rod materials dispersed in silicone oil (3.0 wt%) under electric field strength of 1.0 kV mm^{-1}.