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Electronic Supplementary Information

Direct Photopatternable Organic-Inorganic Hybrid Gate Dielectric for Solution-Processed Flexible ZnO Thin Film Transistors

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Dielectric material	Mobility ($cm^2 V^{-1}s^{-1}$)	Threshold voltage (V)	on/off current ratio	Dielectric Strength ($MV cm^{-1}$)	Dielectric constant
Poly(vinyalcohol)	4.6×10^{-1}	7.01	3.15×10^{1}	0.30	3.57
Poly(4-vinyphenol)	7.37×10^{-2}	3.14	5.38×10^{1}	0.16	3.51
Polyimide	-	-	-	0.66	3.71
Polymethacrylate	6.98×10^{-1}	6.74	2.00×10^{3}	1.42	3.60
SiO_2	4.45×10^{-1}	6.93	1.44×10^{5}	-	3.90

Table S1. Electrical properties of various polymer dielectrics as well as SiO_2. The dielectric films of 200 nm in thickness on heavily doped n^+-Si was sandwiched by Au top electrodes for the measurements of capacitance-voltage (*C*-*V*) and current density-electric field (*J*-E). The dielectric strength was defined as the electric field at a current density of 10^{-6} A cm^{-2}. Solution-processed ZnO-TFTs in a bottom-gate top-contact configuration were fabricated using the various polymer dielectrics. All process temperatures were fixed to 150 ^oC. The dash presents the case if the parameter is not measured or not defined.

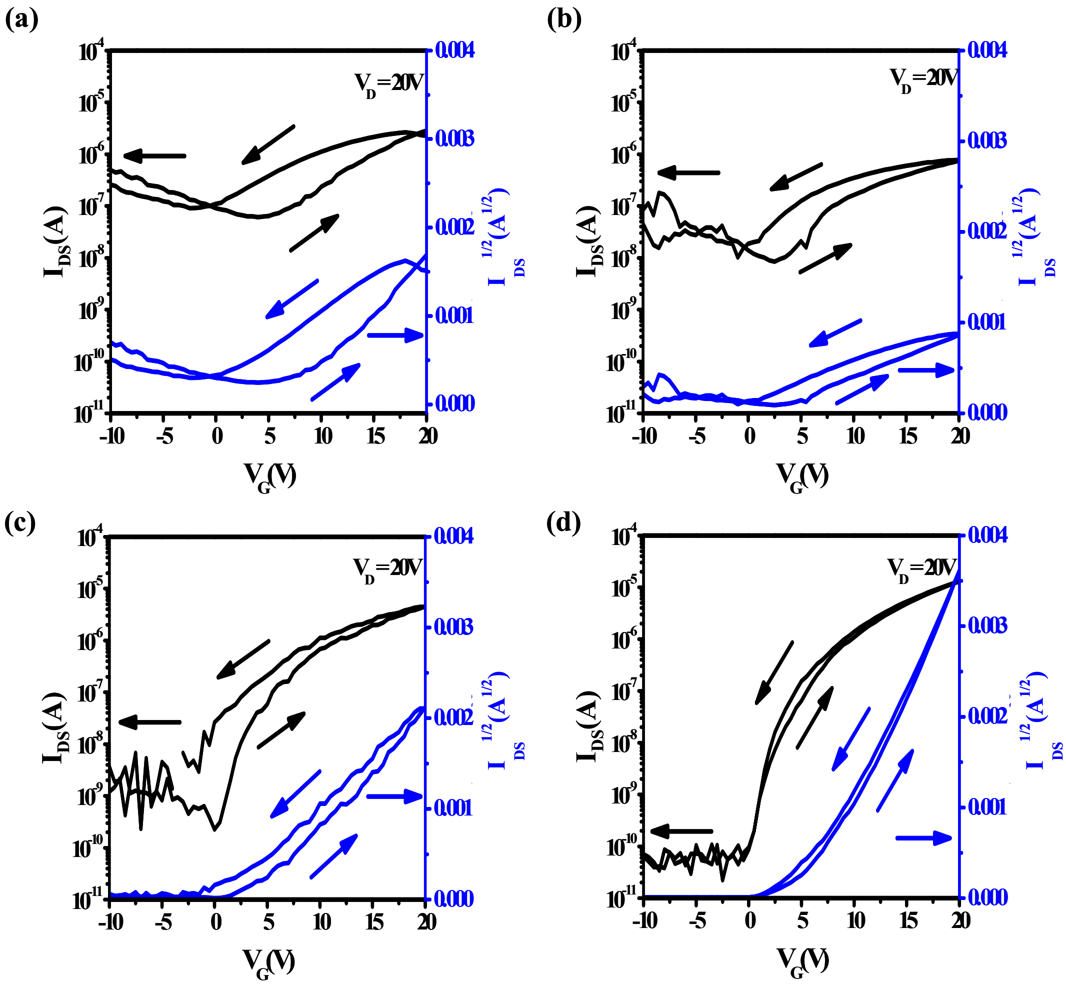

Figure S1. Representative transfer characteristics of ZnO-TFTs fabricated using various polymer dielectrics such as (a) poly(vinyalcohol), (b) poly(4-vinyphenol), and (c) polymethacrylate. Heavily doped silicon wafer was used as a gate electrode and substrate. The tested polymer dielectrics with 600 nm in thickness were annealed at 150 ^{o}C for 2 h. (d) Silicon dioxide with 100 nm in thickness was tested as a reference.

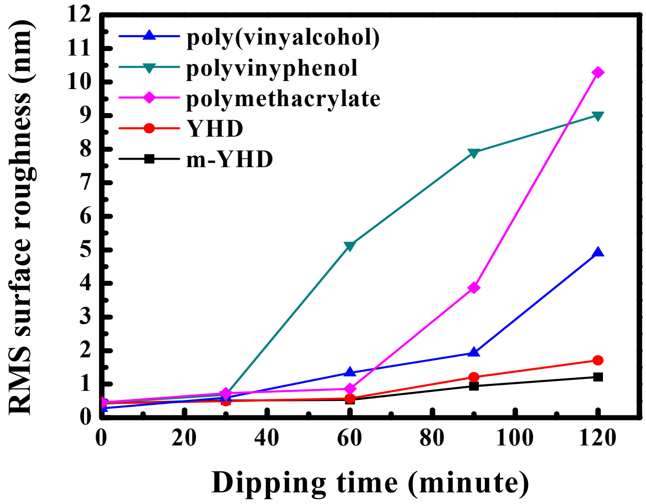

Figure S2. Variation in surface roughness of the YHD, m-YHD, and polymer dielectrics after exposure to the highly basic ZnO precursor solution as a function of soaking times. All solution-processed dielectric films were annealed at 150 ^{o}C, 2 h.

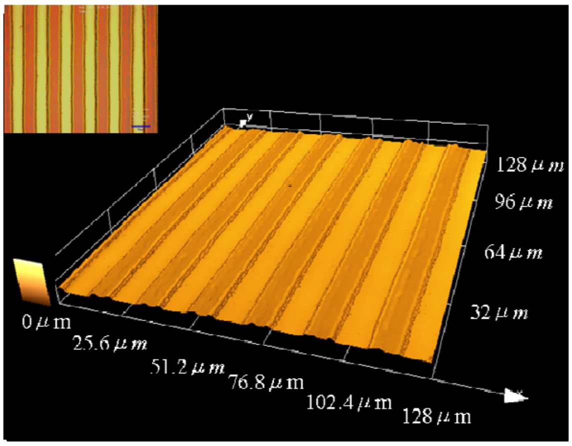

Figure S3. Confocal laser scanning microscopic image of patterned m-YHD films obtained by a photo-lithographic process. The pattern width of the resulting lines is 10 μm.

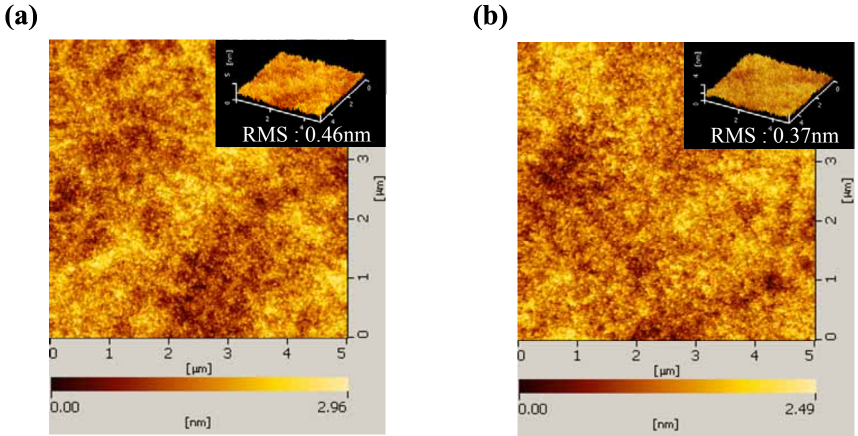

Figure S4. Representative AFM top-view and 3D images of the spin-coated (a) YHD and (b) m-YHD film on silicon wafer. The scan area is 5 μm x 5 μm. Both the hybrid dielectric films have smooth surface morphologies regardless of the presence of cross-linking promoter with the average rms values of 0.461nm (YHD) and 0.374 nm (m-YHD).

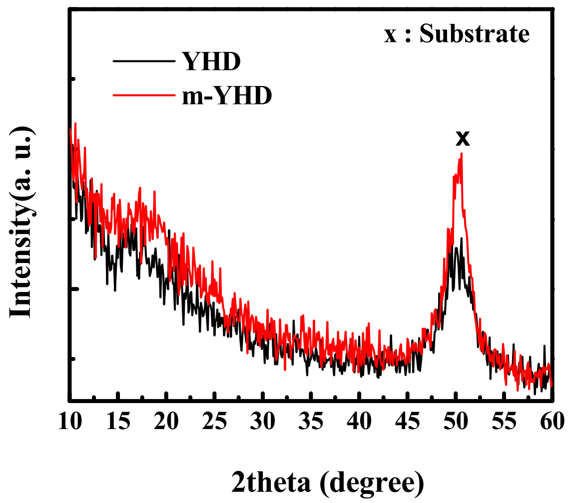

Figure S5. The XRD profile for the YHD and m-YHD films annealed at 150 °C for 2 h. Sharp diffraction patterns observed at $2\theta = 53.8$ and 55.6 originate from the Si wafer substrate. There are no other diffraction peaks that correspond to ZrO_2 or relevant crystalline phase, indicating that YHD and m-YHD are amorphous phase regardless of the presence of cross-linking promoter.

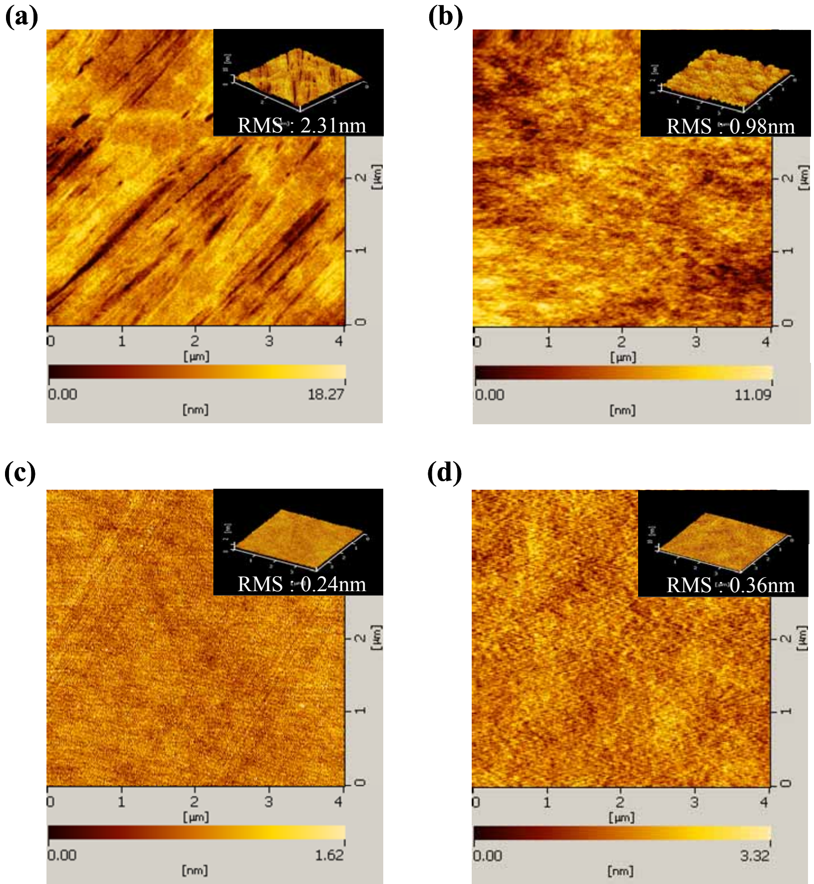

Figure S6. Representative AFM top-view and 3D images showing the surface morphologies of the (a) PES substrate and (b) spin-coated m-YHD film on PES substrate, (c) silicon wafer and (d) spin-coated m-YHD film on silicon wafer. The scan area is 4 μm x 4 μm.