Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C

Copper Oxide Quantum Dots Ink for Inkjet-Driven Digitally Controlled High Mobility Field Effect Transistors

Mohammad Vaseem, A-Ra Hong, Ryun-Tak Kim, and Yoon-Bong Hahn*

Dept. of BIN Fusion Technology, School of Semiconductor and Chemical Engineering, BK 21 Centre for Future Energy Materials and Devices, and Nanomaterials Processing Research Center, Chonbuk National University, Jeonju 561-756, South Korea

Supplementary information

Table 1. Formulation condition of CuO quantum-based inks

Ink sample No.	CuO NPs (wt %)	Water (wt %)	Ethanol + Isopropyl alcohol (wt %)	Ethylene glycol (wt %)	Surface tension (mN/m)	Viscosity (cP)
A	10	60	20 + 5	5	33.707	3.34
B	20	50	20 + 5	5	35.426	4.14
C	30	40	20 + 5	5	37.915	4.80

Table 2. Comparison table for performance parameters among p-type materials, process and Mobility observed in literature based TFTs

Material	**Process**	**Temp [^{0}C] as-synthesized/ post annealed**	**Substrate/ dielectric**	**On/off current ratio**	**Mobility (μ), $cm^2/V.s$**	**Reference**
SnO_2	Thermal evaporation	RT/100	Si/SiO_2	$\sim10^2$	4.7×10^{-3}	34
SnO	electron beam evaporation	RT/400	Si/SiO_2	$\sim10^2$	0.87	35
SnO	PLD	RT/250	Si/SiO_2	$\sim10^3$	0.75	36
NiO	EDLT	RT	NiO/ electrolyte	~130	1.6×10^{-4}	37
Cu_2O	PLD	500	Si-SiO_2/ HfON	$\sim3\times10^6$	4.3	38
Cu_2O	magnetron sputtering	RT	ITO-PET/AlN	$\sim3.9\times10^4$	2.4	39
CuO NWs	Thermal evaporation	500/RT	Si/SiO_2	~100	15	40
CuO	rf sputtering	RT/300	Si/SiO_2	$\sim10^4$	0.4	41
CuO NPs	Inkjet-Printed dot pattern	100/RT	Si/SiO_2	$\sim0.2\times10^3$	16.6	This work
CuO NPs	Inkjet-Printed dot pattern	100/MAA (2 min)	Si/SiO_2	$\sim7.0\times10^3$	31.22	This work

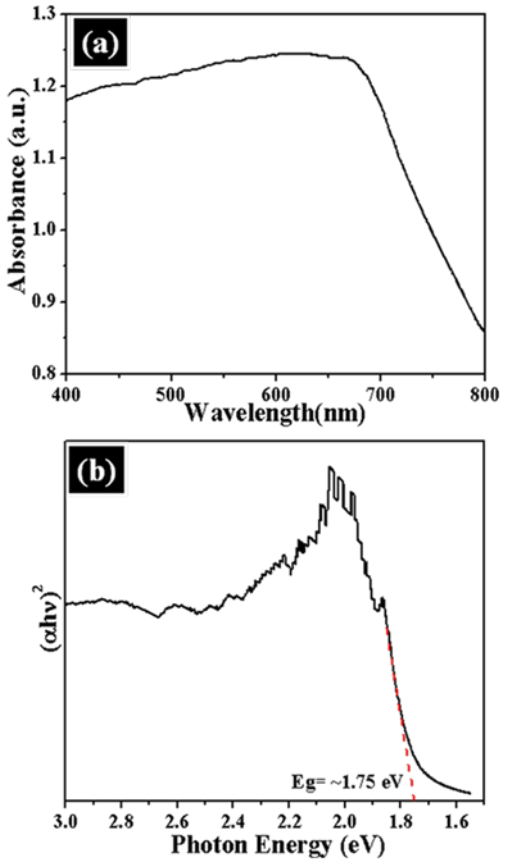

Figure S1. (a) UV-DRS and (b) plots of $(\alpha h\nu)^2$ *vs.* photon energy for as-synthesized CuO QDs.

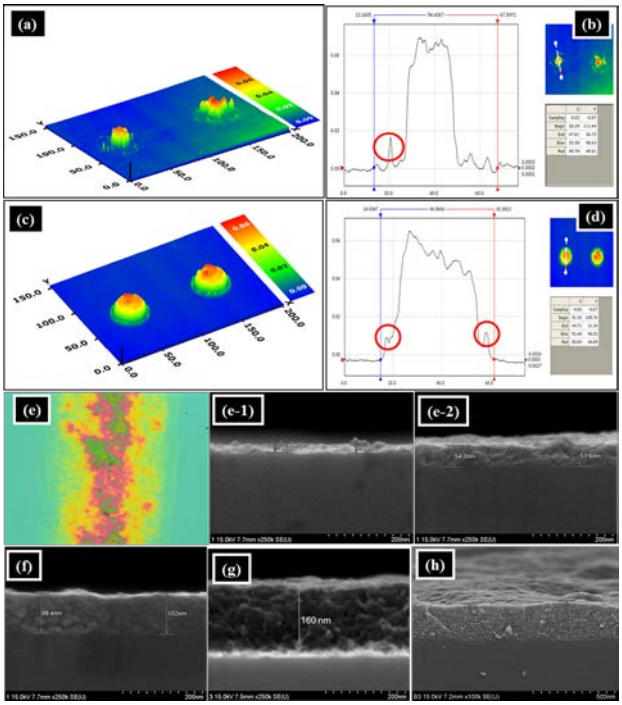

Figure S2. (a) 3D surface profiler image of dots and (b) width scan of a single dot printed using ink A (10 wt % CuO QDs); (c) 3D surface profiler image of dots and (d) width scan of a single dot printed with ink B (20 wt % CuO QDs); (e) CCD microscopic image of the CuO line with single-layer printing and its corresponding cross-sectional FESEM images showing at edge (e-1) and at middle (e-2) areas of the CuO line printed using ink B; Cross-section FESEM images of the CuO line printed with 2 overprinting (f), 3 overprinting (g) and 4 overprinting (h) using ink B.

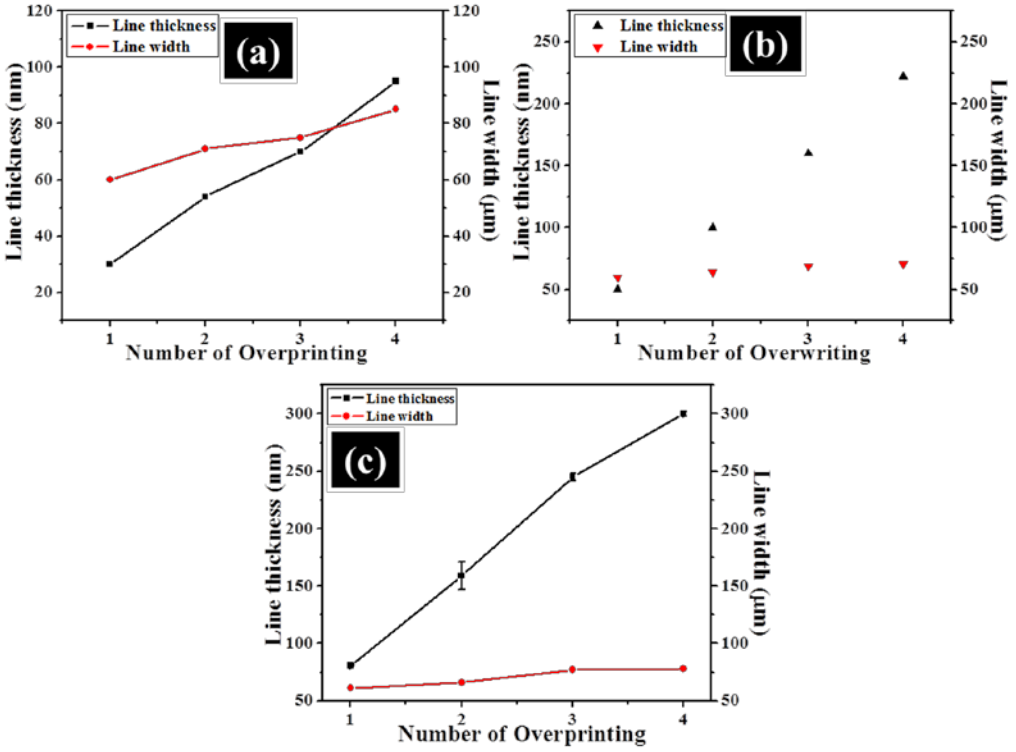

Figure S3. CuO line thickness and line width as a function of number of overprinting using (a) ink A, (b) ink B and (c) ink C.

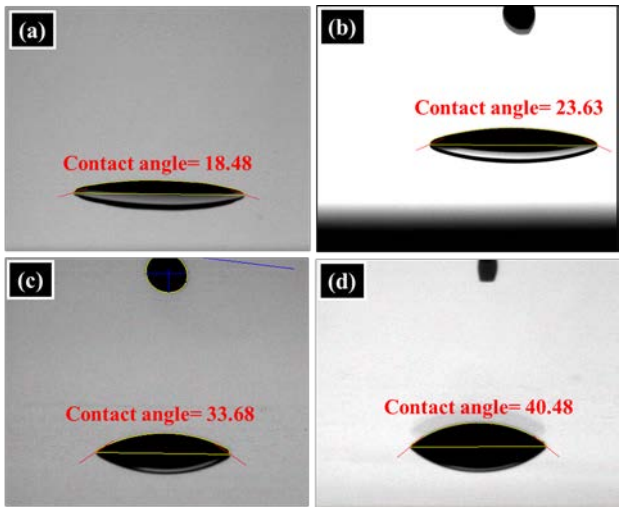

Figure S4. Contact angle of droplets using as-formulated CuO ink C on various substrates i.e. (a) Si/SiO_2,(b) Bare glass, (c) PI and (d) ITO.

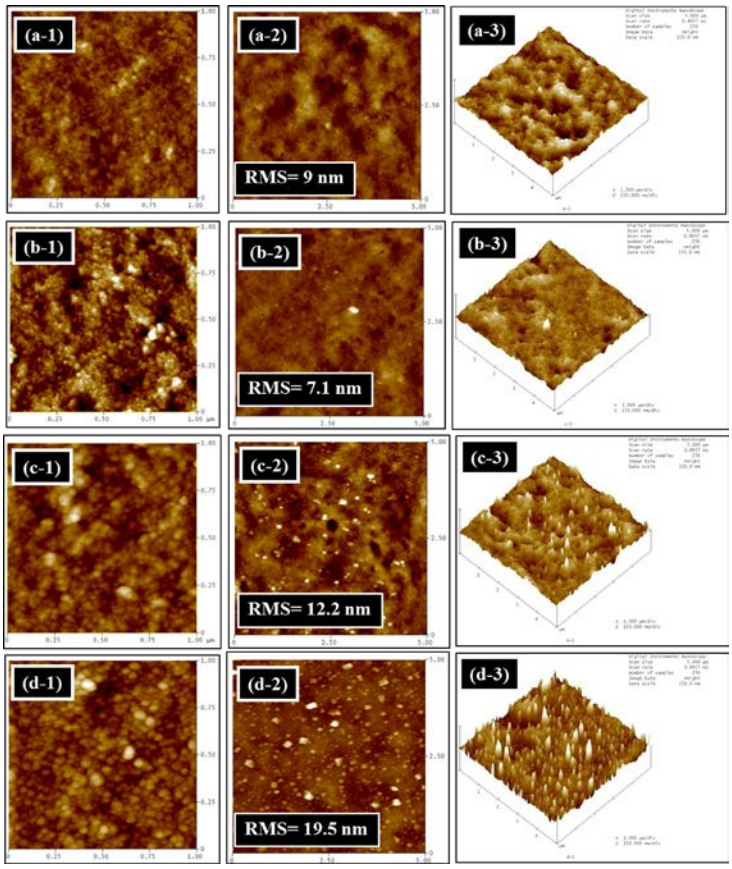

Figure S5. AFM images of CuO nano-films after conventional annealing at different temperatures: (a) 100 ^{0}C, (b) 150 ^{0}C, (c) 200 ^{0}C, and (d) 250 ^{0}C. CuO lines were printed using ink C.

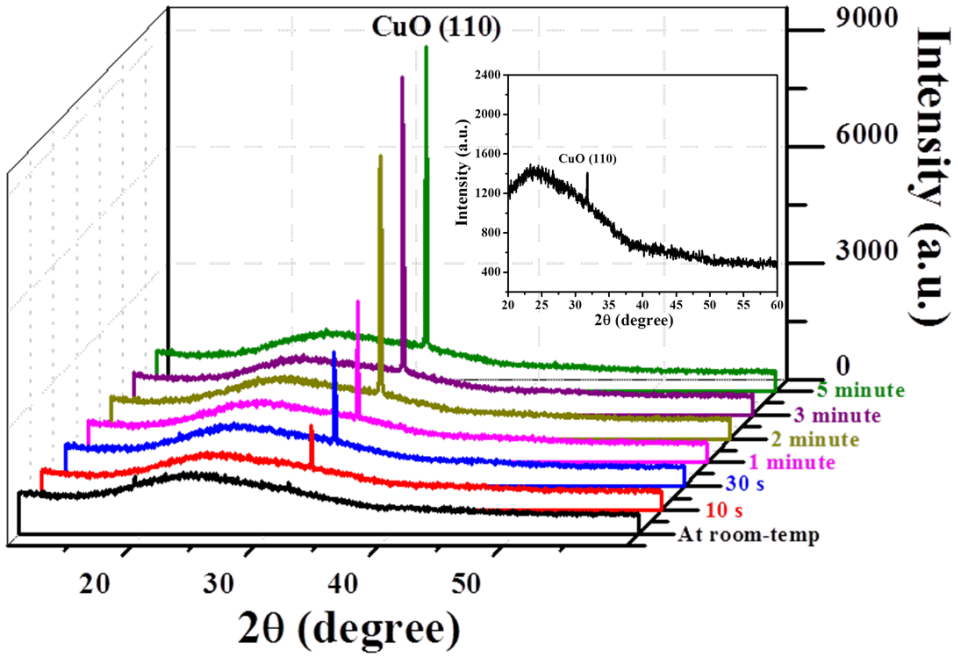

Figure S6. Typical X-ray diffraction patterns for the printed CuO nanofilms after microwave-assisted annealing (MAA) at different times. CuO nanofilms were printed using ink C. In inset showing magnified XRD pattern of CuO nanofilms at room-temperature