Inkjet Printing and Photonic Sintering of Silver and Copper Oxide Nanoparticles for Ultra-Low-Cost Conductive Patterns

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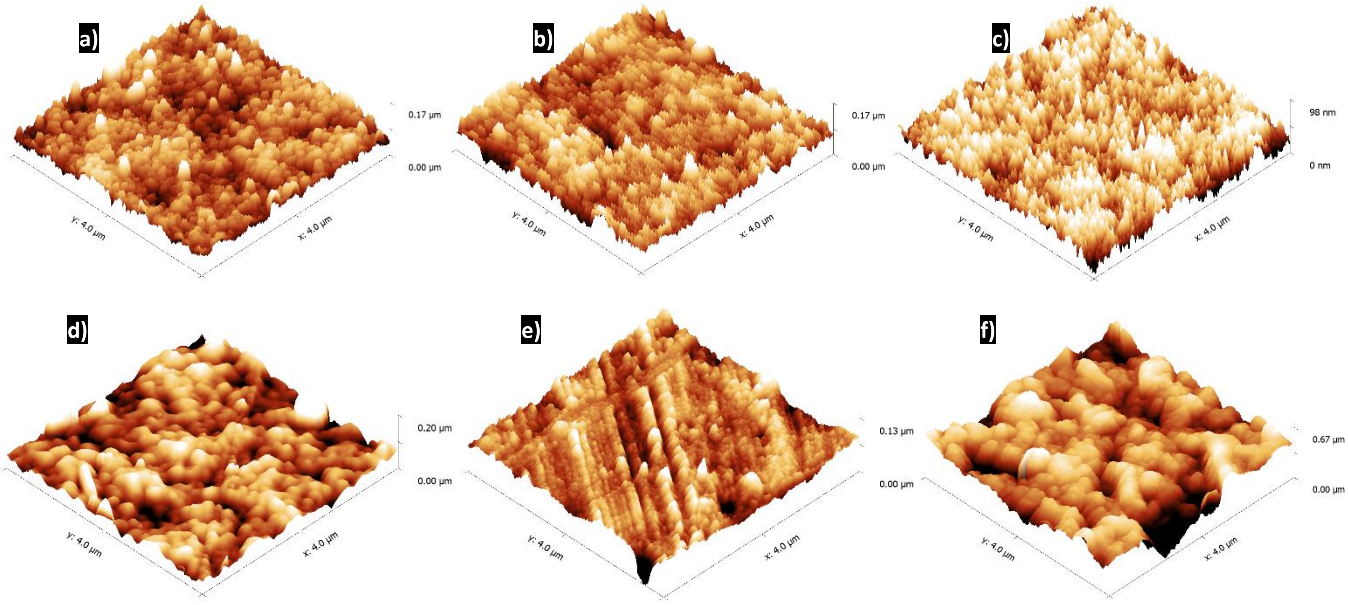
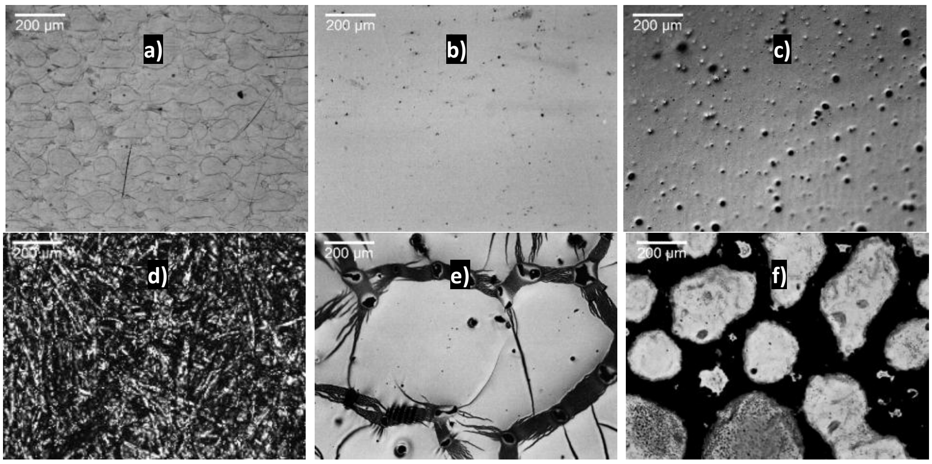
Suppl. Table 1: Substrates found suitable for inkjet printing of silver and copper oxide nanoparticle ink are divided into four groups. Substrates numbered with P are white paper-based and porous, with T are transparent polymer-based and porous, W are white polymer-based and porous N are white paper-based and non-porous, M are transparent polymer-based and non-porous.

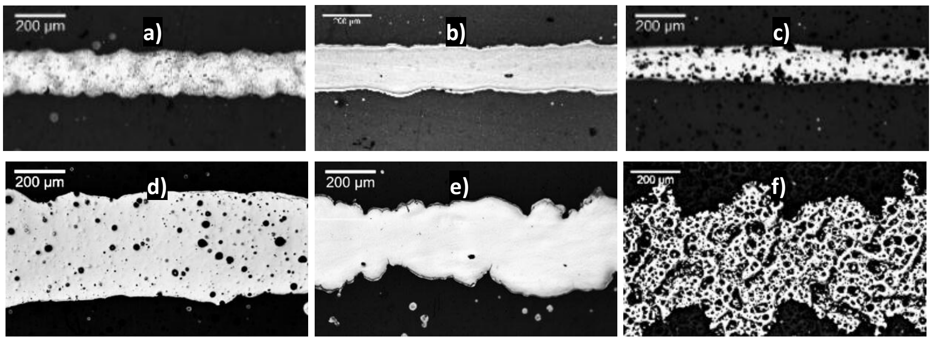
No.	Manufacturer	Product Name	R_S Ag pre (mΩ/□)	R_S Ag post (mΩ/□)	R_S Cu post (mΩ/□)
P1	Mitsubishi Paper Mills	Nano Benefit Series NB-RC-3GR120	794	71.0	820
P2	Schoeller Technocell	p_e:smart type 2	40.1×10^{3}	179	
P3	Schoeller Technocell	p_e:smart type 3	2324	61.1	1230
P4	Dataplot	Emblem WAPUM Glossy 240g	1165	73.6	710
P5	Pelikan	Geha Photo paper P05	3079	78.1	335
P6	Canon	Glossy Photographic Paper	2819	94.4	484
P7	HP	Universal Semigloss Photographic Paper	1862	55.4	533
P8	Canon	Semi-Matte Photographic Paper	385	113	484
P9	Dataplot	Emblem WAPUM Semimatte 240g	3496	74.2	430
T1	Mitsubishi Paper Mills	Nano Benefit Series NB-TP-3GU100	473	74.1	664
T2	Novacentrix	Novele IJ-220	5471	64.7	536
T3	Mitsubishi Paper Mills	InkJet Film UC100	52.0×10^{3}	67.7	454
T4	Folex	Reprojet P HD	1504	195	1966
T5	Folex	Reprojet P HDM	1875	143	1134
T6	ColorGATE	Reprofilm HD	2519	135	1784
T7	ColorGATE	Screenfilm Waterbased	2375	124	1309
T8	ESC	ScreenJet Film	403	156	456
T9	R. Rauch	Repro-UV	1211	149	2155
T10	R. Rauch	Repro-UV II	1029	151	1428
W1	Mitsubishi Paper Mills	Nano Benefit Series NB-WF-3GF100	794	67.7	801
W2	Unknown	Greyback	863	130	2644
N1	Schoeller Technocell	p_e:smart type 1	131×10^{3}	361	$> 1 \times 10^{9}$
N2	Arjowiggins	Powercoat HD 230	$> 1 \times 10^{12}$	$> 1 \times 10^{9}$	$> 1 \times 10^{9}$
N3	Stora Enso	LumiArt	7.55×10^{6}	302	$> 1 \times 10^{9}$
N4	Konica Minolta	Photo Paper	6.90×10^{6}	267	$> 1 \times 10^{9}$
N5	Stora Enso	LumiSilk	21.6×10^{6}	166	$> 1 \times 10^{9}$
M1	MGW Office Supplies	Clear Laser & Copy Foil	2151	195	$> 1 \times 10^{9}$
M2	Viking	Transparency Film	2142	150	$> 1 \times 10^{9}$
M3	Folex	GO-HC	2060		$> 1 \times 10^{9}$



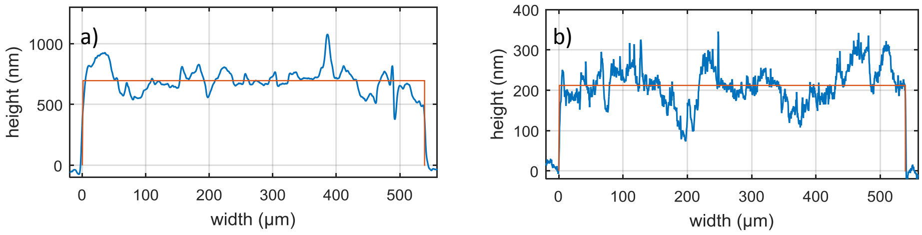
Suppl. Figure 1: AFM images of selected substrates and their roughness within a 4 x 4 µm² area:
a) P4: 12,0 nm, b) P8: 16,3 nm, c) T7: 7,4 nm, d) M2: 10,1 nm, e) N2: 7,2 nm, f) N3: 24,4 nm



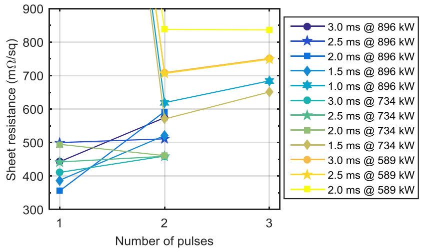
Suppl. Figure 2: Microscope images of printed areas on different substrates: a) porous inkjet media (P9), b) smooth non-porous film. The homogeneous film is disturbed by stains of different sizes. All these three surfaces exhibit a shiny silver layer and low sheet resistances are obtainable. This results in higher brightness of the ink-covered areas in the microscope images. film (N8), c) rough non-porous film, d) absorptive substrates (office paper), e) low-adhesion substrates, f) low-wettability substrates. The silver ink is shown brighter than the substrate. Scale bar: 200 µm



Suppl. Figure 3: Microscope images of printed lines on different groups of substrates. (a) porous inkjet media (P9), (b) smooth non-porous film (M2), (c) rough non-porous film, (d) high-wettability substrates, (e) substrates with high but irregular wettability, (f) rough high-wettability substrates The silver ink is shown brighter than the substrate.



Suppl. Figure 4: a) Profile of a 500 µm silver line on substrate T8 measured with a profilometer. Red: Average height of 696 nm between 0 and 539 µm. b) Profile of a 500 µm copper line on substrate T2 measured with a profilometer. Red: Average height of 212 nm between 0 and 539 µm.



Suppl. Figure 5: Conductivity achieved after a single high-energetic and high-power pulse. For lower energies and powers, two pulses are necessary. A higher number of pulses decreases the sheet resistance.