Hybrid nanomaterial inks for printed resistive temperature sensors with tunable properties to maximize sensitivity (SI)

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SI1: Profilometry data for typical aerosol jet printed resistive temperature sensor

The profile measurements were collected using the ZYGO NewView 9000 optical surface profiler (ZYGO Corporation). To prepare the sample for profile imaging, the Kapton substrate with aerosol jet printed resistive temperature sensor is mounted onto a glass slide using adhesive tape and is coated with a 60 nm layer of platinum. The platinum is applied to the substrate using the Leica EM ACE600 sputter coater (DANAHER Corporation).

The height of the printed line is calculated by taking the average value of the slice from one edge of the sensor to the other edge as shown in Figure S1. The average height of the printed line is 0.40 μm.

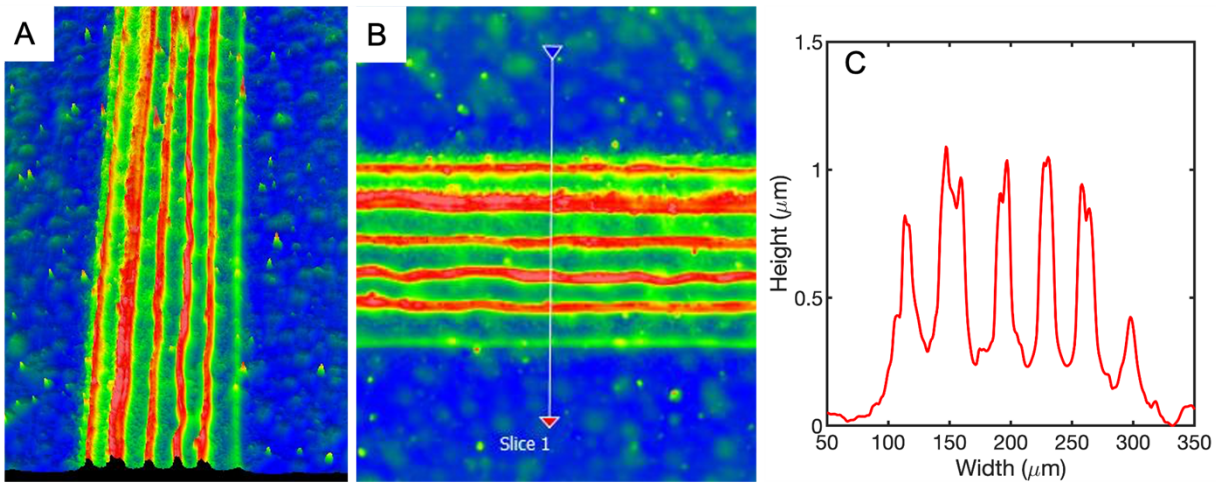

Figure S1. Profilometry measurement results for a typical aerosol jet printed temperature sensor (A) 3D scan of the trace, (B) line slice of the trace, (C) Thickness profile of the trace

SI2: EDS element mapping data

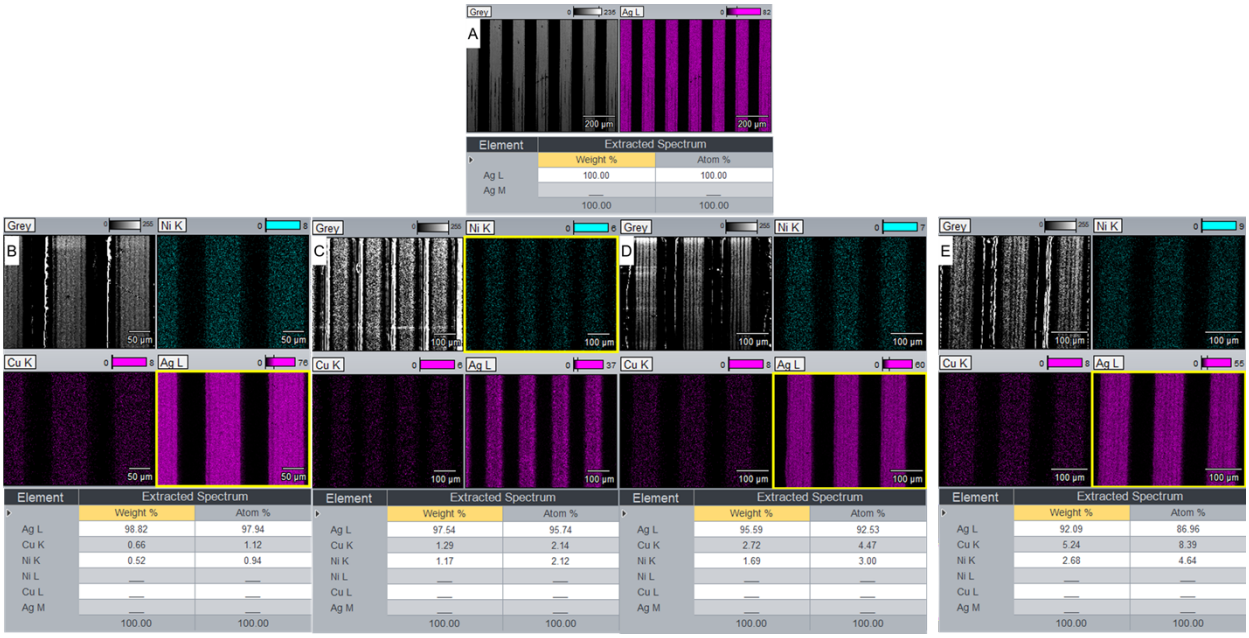

Figure S2. EDS mapping data for aerosol jet printed resistive temperature sensors with various inks (A) 0% Ni-Cu ink, (B) 10% Ni-Cu ink, (C) 20% Ni-Cu ink, (D) 30% Ni-Cu ink, (E) 40% Ni-Cu ink.

SI3: TGA measurement results

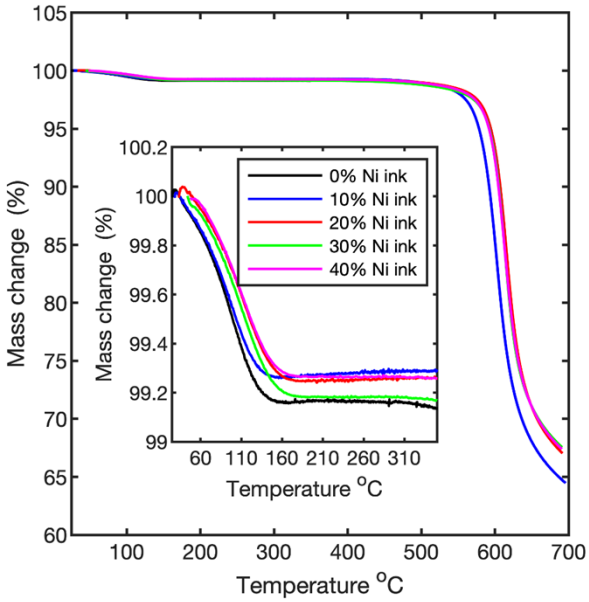

Figure S3. TGA results for the aerosol jet printed resistive temperature sensors with various ink compositions (The inset is a zoomed in figure in the temperature range from 25 °C to 350 °C).

SI4: Bending strain test setup

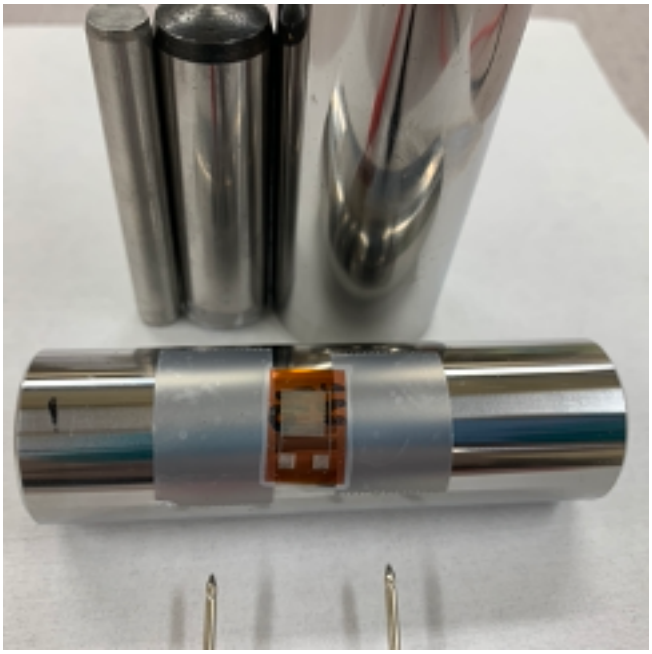

Figure S4. Aerosol jet printed sensors were mounted onto cylindrical rods for bending test measurement

SI5: Comparing sensor performance to literature data

Table S1. Comparison of TCR and sensitivity

No.	TCR (10^{-3} /°C)	Sensitivity	temperature range (°C)	Ref.
1	1.076	0.155	0-100	[1]
3	1.77	0.02	28-90	[2]
4	1.1	0.737	-20-60	[3]
5	2.99	0.0000598	10-80	[4]
6	1.37	0.774	30-140	[5]
7	1.625	0.85	20-80	[6]
8	1.7	0.015	20-140	[7]
9	2.35	0.15	22-150	This work
10	1.04	0.59	22-150	This work

References:

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SI5: The procedure for Spin coating Polyimide

Polyimide precursor (575771-250ML, Millipore Sigma) was spin coated onto printed sensors with Laurell WS-650HZ-23NPP/UD2 Spin Coater (Laurell Technologies Corporation). Spin coating process as following:

Step 1: spin at 500 rpm for 10 seconds

Step 2: spin at 2000 rpm for 20 seconds

Step 3: spin at 5000 rpm for 30 seconds

After spin coating, the coated samples were baked at 350 °C for 30 minutes to form Polyimide film.