Supplementary Information

Graphene ink for 3D extrusion micro printing of chemo-resistive sensing devices for volatile organic compounds detection

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Contact angle measurement:

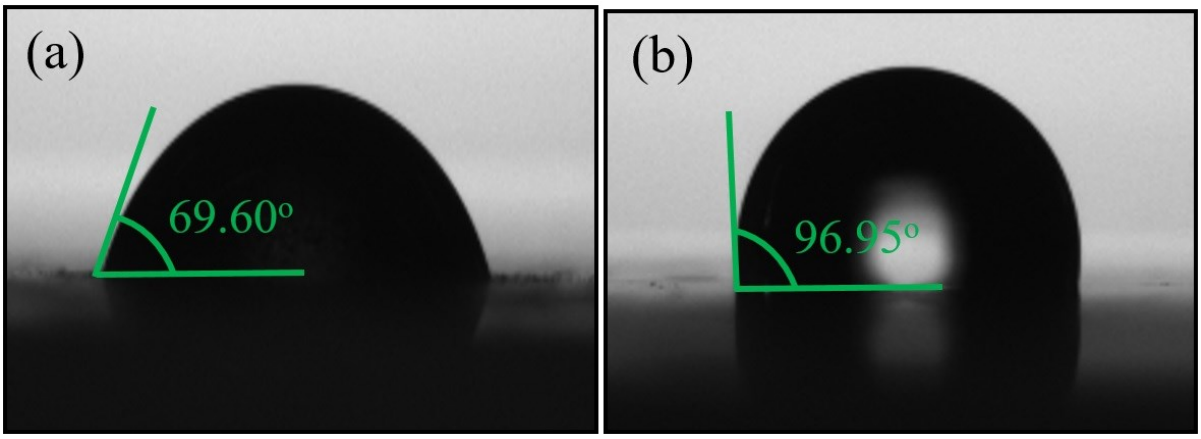

Fig. S1. Contact angle measurement of printed graphene ink (c) before annealing, and (d) after annealing at 250 °C temperature.

Table S1. Contact angles and calculated surface energy of printed graphene ink (a) before annealing and (b) after annealing at 250 °C temperature.

Sample	Contact angle (°)	Owens–Wendt method[25]			Wu method[26]		
		$\gamma_{sv}(mN/m$	$\gamma_{sv}^{D}(mN/m)$	$\gamma_{sv}^{p}(mN/m)$	$\gamma_{sv}(mN/m)$	$\gamma_{sv}^{D}(mN/m)$	$\gamma_{sv}^{p}(mN/m)$
Graphene ink (before annealing)	69.60	97.45	43.58	54.27	108.69	56.83	51.84
Graphene ink (after annealing)	96.95	96.95	0.005	0.005	-3.8	-0.98	-2.05

Table S2. Surface area and surface volume calculation for 3D printed sensor and conventional sensor.

For 3D printed sensor:	***For conventional sensor (non-printed):***
No of printed line=13, *Length (L) =6.60 mm,* *width (d) = 0.6 mm,* *average thickness (T_{avg}) = 15 µm = 0.015 mm* *Active area $_{eff}$ ($A_{printed\ sensor}$) = N × (L × d) = 13 × (6.60 × 0.6) = 51.48 mm^2*	*No of spherical curve (drop cast) = 1,* *radius (r) =2.5 mm,* *average thickness (T_{avg}) = 145 µm = 0.145 mm* *Active area $_{eff}$ ($A_{printed\ sensor}$) = N × πr^2 = 1 × (3.1415 × (2.5)^2) = 19.625 mm^2*
Active volume $_{eff}$ = Active area eff × T_{Avg} *= 51.48 × 0.015* *= 0.7722 m^3*	*Active volume $_{eff}$ = Active area $_{eff}$ × T_{Avg}* *= 19.625 × 0.145* *= 2.845 m^3*
SA:V = Active area $_{eff}$/ Active volume $_{eff}$ = 51.48 / 0.7722 = ***66.66***	*SA:V = Active area $_{eff}$/ Active volume $_{eff}$ = 19.625 / 2.845 =* ***6.91***

Humidity effect:

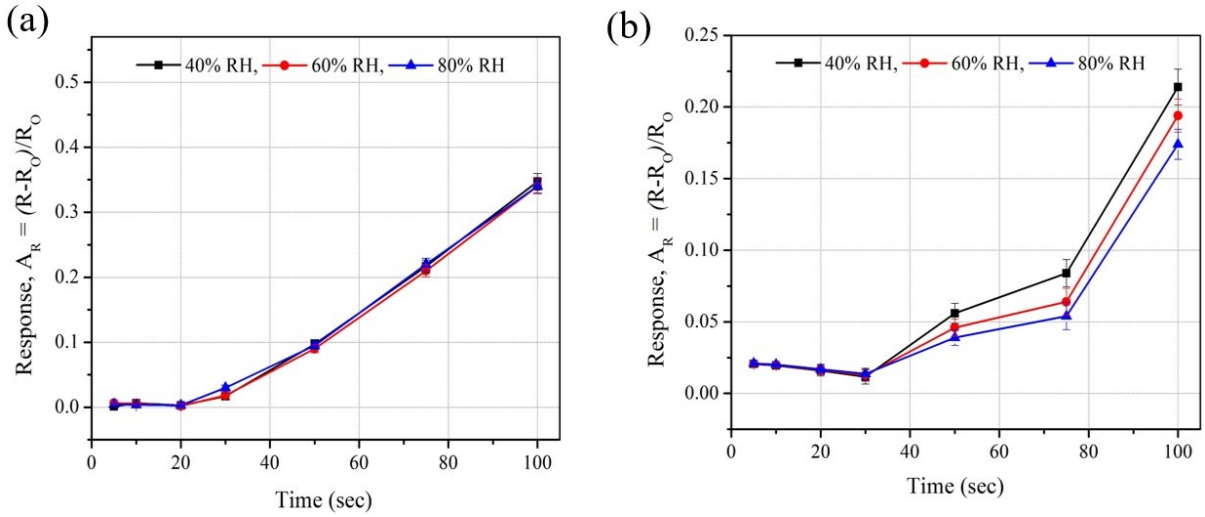

Fig. S2. Transient response of printed sensors to (a) methanol and (b) acetone vapour under different humidity at room temperature (20 °C).

Sensor stability and durability:

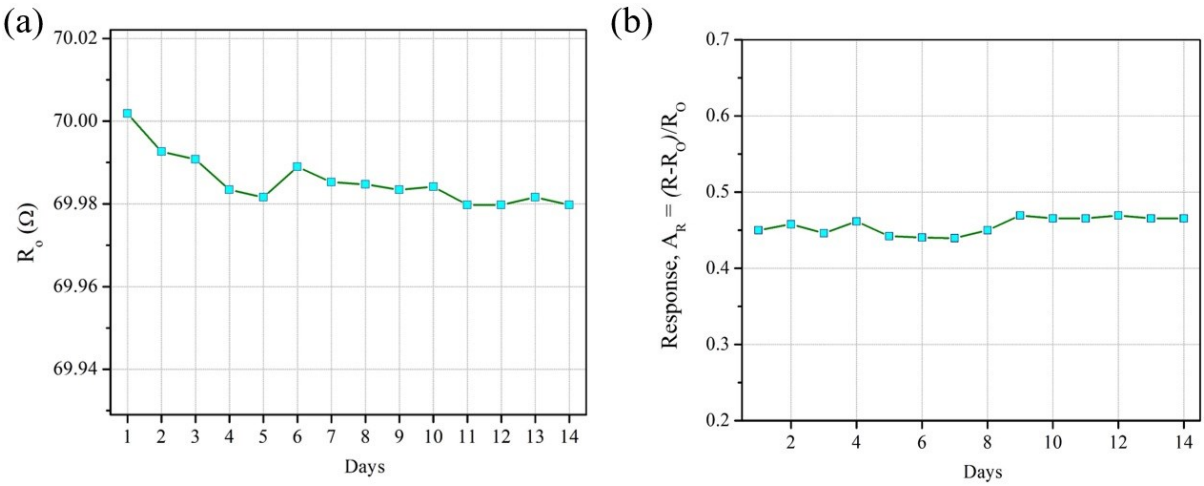

Fig. S3. Time reliance of the printed sensor (c) baseline resistance value and (d) response value, monitored over a fourteen-day period, where on each day the printed sensor was exposed to saturated ethanol biomarkers at room temperature (20 °C).