Supplementary Materials

APCVD setup

All APCVD runs were conducted using a 1.5 m long quartz tube (GE214A – Multi-lab Quartz & Ceramic Technology) placed in a 3-zone furnace (0.75 m heat zone, PSC 12/90/600H Lenton, Hope, UK). A gas control unit was used to deliver hydrogen (99.95%), methane (99.5 %) as the hydrocarbon feedstock, argon (BOC 99.98%) while nitrogen (99.998%) was used to provide pressure to open the valves. A rotary vane pump (Edwards RV12) was used to evacuate the reaction tube and a one-way pressure relief valve (PRV) was connected to maintain atmospheric pressure in the tube during the APCVD process.

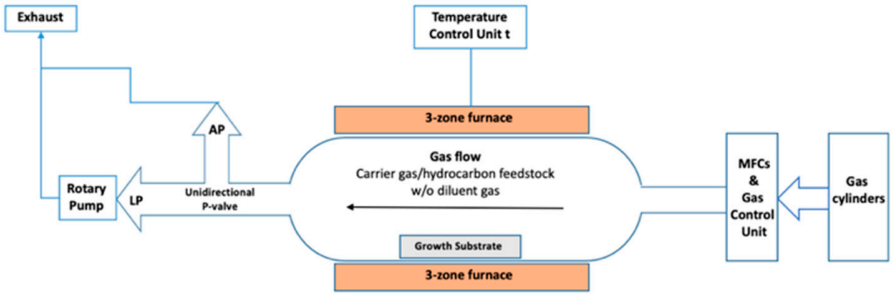

Figure S1. Schematic of the used CVD apparatus. [1]

Cu:In Alloy: Compositions/preparation

Pure metals In and Cu, with purity 99.995% and 99.9999% with a maximum lump size of 15 mm and 5 mm respectively, all metals being used as-received. The substrates (Pure In or Cu-In alloy) were held in tungsten boats (AGE439, 32 mm × 0.05 mm).

The Cu and In pellets were placed in the hearth with eight rooms that allowed the production of five button-shape alloys of different compositions in the same run. The melting process, which is achieved under an argon gas atmosphere (99.999%), started with the melting of a pure zirconium (Zr) getter to remove the residual oxygen from the chamber of the arc melter. To ensure the compositional homogeneity of the obtained alloy, the pre-alloy button was inverted and re-melted six times using an electric current ranging from 175 A to 250 A. The alloy buttons for each composition were then weighed again to compare the initial total weight with the final weight after arc-melting.

The weight in grams for each metal was simply calculated by following equation to give the correct composition based on wt.% for a total weight of 5 (g).

$$\frac{Weight\% \times total\ weight\ (g)}{100\%}$$

Table S1 The weight of elemental metal used to form each Cu-In alloy composition.

Composition wt.%	Copper Weight (g)	Indium Weight (g)
Cu_{90}-In_{10}	4.500	0.501
Cu_{70}-In_{30}	3.448	1.500

Cu_{50}-In_{50}	2.505	2.504
Cu_{40}-In_{60}	2.020	3.032
Cu_{20}-In_{80}	1.010	4.008

Table S2. Summary of the used APCVD graphene growth parameters on liquid In to study the effect of CH_4 concentration and residence time.

P_T (mbar)	T (°C)	t (min)	H_2 (sccm)	Ar (sccm)	CH_4 (sccm)	P_H (mbar)	P_{CH} (mbar)	τ (s)	I_{2D}/I_G	I_D/I_G
1013	1120	5	25	250	5	90.4	18.08	12.8	0.77	0.79
1013	1120	5	30	300	5	90.7	15.1	10.7	0.89	0.82
1013	1120	5	40	400	5	91.0	11.38	8.0	1.36	0.93
1013	1120	5	50	500	5	91.3	9.12	6.5	1.36	0.87

Table S3. APCVD graphene growth parameters on liquid In using different H_2 flow rates.

P_t (mbar)	T (°C)	t (min)	H_2 (sccm)	Ar (sccm)	CH_4 (sccm)	P_H (mbar)	P_{CH} (mbar)	τ (s)	I_{2D}/I_G	I_D/I_G
1013	1120	5	40	500	5	74.3	9.3	6.60	1.00	1.65
1013	1120	5	35	500	5	65.6	9.4	6.66	1.20	1.23
1013	1120	5	30	500	5	56.8	9.5	6.73	1.56	0.88
1013	1120	5	25	500	5	47.8	9.6	6.79	1.12	0.37
1013	1120	5	20	500	5	38.6	9.7	6.85	1.06	0.34

Table S4. APCVD graphene growth parameters on liquid In using different Ar flow rates.

P_T (mbar)	T (°C)	t (min)	H_2 (sccm)	Ar (sccm)	CH_4 (sccm)	P_H (mbar)	P_{CH} (mbar)	P_{H+CH} (mbar)	τ (s)	I_{2D}/I_G	I_D/I_G
1013	1120	5	20	300	5	62.3	15.6	77.9	11.0	0.82	1.31
1013	1120	5	20	400	5	47.6	12	59.6	8.4	0.95	0.89
1013	1120	5	20	500	5	38.6	9.6	48.2	6.8	1.06	0.70
1013	1120	5	20	600	5	32.4	8.1	40.5	5.7	1.27	0.47
1013	1120	15	20	600	5	32.4	8.1	40.5	5.7	1.20	0.40
1013	1120	5	20	700	5	28	7	35	4.9	1.54	0.72
1013	1120	15	20	700	5	28	7	35	4.9	1.10	0.36
1013	1120	5	20	800	5	24.5	6.1	30.7	4.3	1.74	0.82
1013	1120	15	20	800	5	24.5	6.1	30.7	4.3	1.20	0.30
1013	1120	5	20	1000	5	19.7	5	24.7	3.5	1.70	0.50
1013	1120	15	20	1000	5	19.7	5	24.7	3.5	1.20	0.20

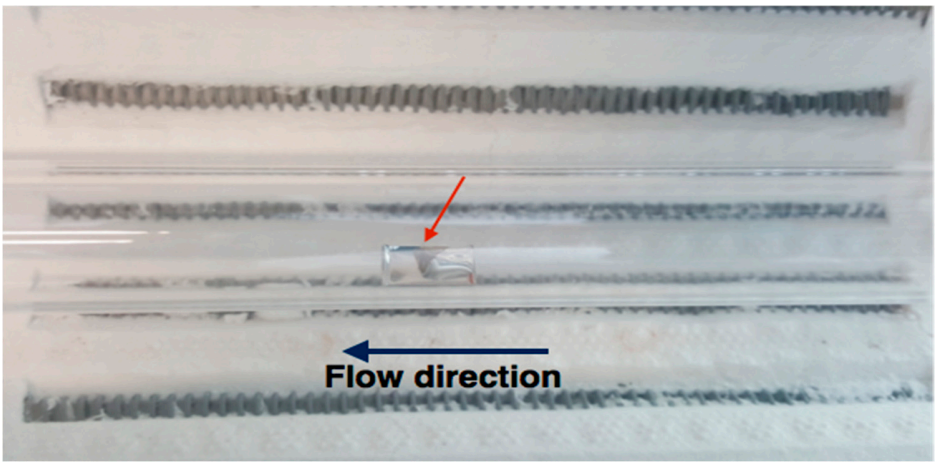

Figure S2. Photograph showing the position of the sample in the APCVD reactor in the middle of the furnace hot zone while the sooty patch where graphene was deposited on the surface is shown as observed, towards the exhaust end of the reactor.

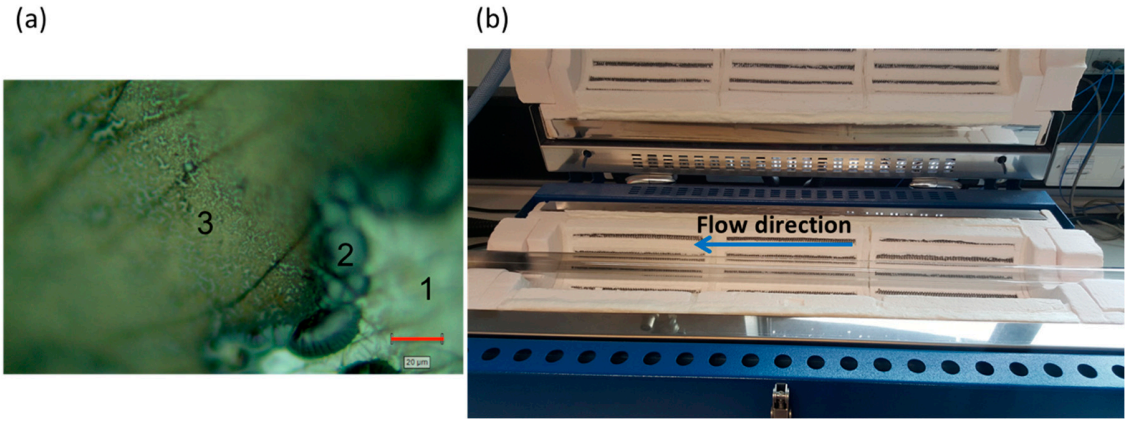

Figure S3. APCVD graphene grown on liquid In using Ar flow rate of 1000 sccm and a growth time of 15 minutes. (a) Optical image of the graphene film showing three regions noted by numbers where one has no graphene, two has early deposition and three is the grown graphene film. (b) Photograph of the CVD reaction tube that shows the change in its colour as it becomes less transparent. This shows that the growth time does not affect the degree of coverage but leads to a slight increase in the sooting of the reaction tube.

Table S5 Optimised growth parameters for APCVD graphene on liquid In.

P_t (mbar)	T (°C)	t (min.)	$Ar:H_2:CH_4$ (sccm)	P_{H2} (mbar)	P_{CH4} (mbar)	P_{Ar} (mbar)	τ (s)
1013	1120	5	500:20:5	38.6	9.6	964.8	6.8