

Supplementary Information

1 Precursors

Name	Abbrev	Process	Purity (%)	Supplier
Soda lime glass	SLG	back contact	Menzel Glaser	Fisher Scientific
Mo target	Mo	Back contact	99.95	Testbourne
Thiourea	TU	Solution/buffer	≥ 99.0	Sigma Aldrich
Cysteamine	CA	Solution	≥ 99.2	Chem-Impex Int.
Copper (II) oxide	CuO	Solution	99.98	Alfa Aesar
Zinc oxide	ZnO	Solution	99.99	Sigma Aldrich
Tin sulphate	SnSO ₄	Solution	≥ 95	Sigma Aldrich
Selenium shot	Se	Selenisation	99.999	Alfa Aesar
Cadmium sulphate	CdSO ₄	Buffer	≥ 99.0	Sigma Aldrich
Ammonium hydroxide	NH ₄ OH	Buffer	28-30 wt%	Acros Organics
ZnO target	ZnO	Front contact	99.99	Plasmaterials
Al ₂ O ₃ :ZnO (0.5% by wt.)	AZO	Front contact	99.99	Innovnano

Table 1: The materials used throughout production

2 Absorber

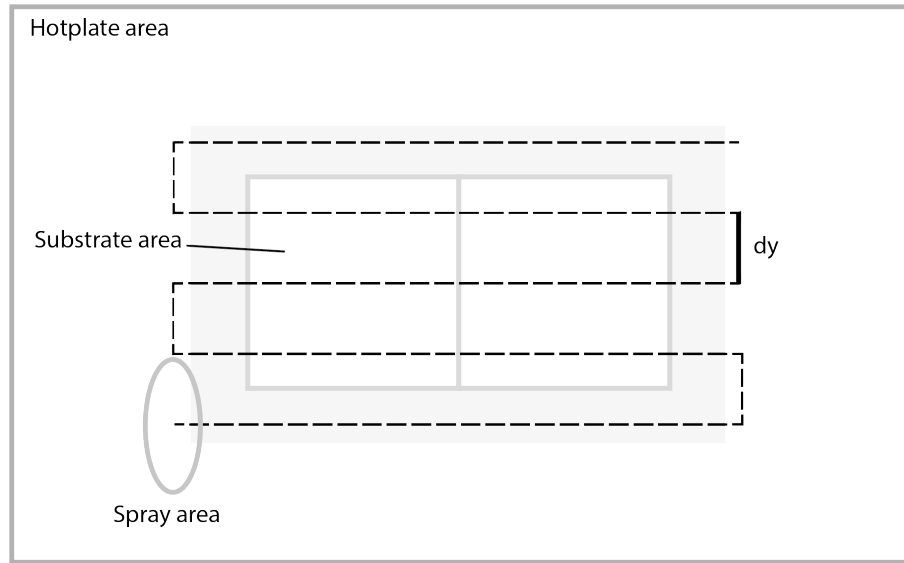


Figure 1: Image showing the motion of the deposition spot over the surface of the hotplate whilst pyrolysing

2.1 Deposition execution

We start the Labview program as the substrate touches the hotplate at temperature T ; a time t_1 elapses before the stages begin to move. They move with velocity v and displace a distance dy .

After spraying a full layer it pauses for a time t_2 before returning to the start and spraying again. It sprays n layers and pauses a time t_3 after the last layer.

The solution is delivered to the nozzle at rate r_1 where the nozzle atomises it at 120kHz with power p . The atomised solution is directed downwards using N_2 gas flowing at rate r_2 from a nozzle-to-hotplate distance of h .

2.2 Deposition parameters

Code	Parameter	Units	Value
T	Hotplate	°C	350
t_1	PreDwell	s	45
t_2	MidDwell	s	30
t_3	PostDwell	s	180
v	Stage speed	mm/s	40
dy	Sidestep	mm	10
r_1	Flow rate	ml/min	1.5
r_2	Gas flow	L/min	6
p	Power	W	4.5
n	Layers	-	12
h	Nozzle height	cm	5.5

Table 2: Table of spray deposition parameters

3 Selenisation

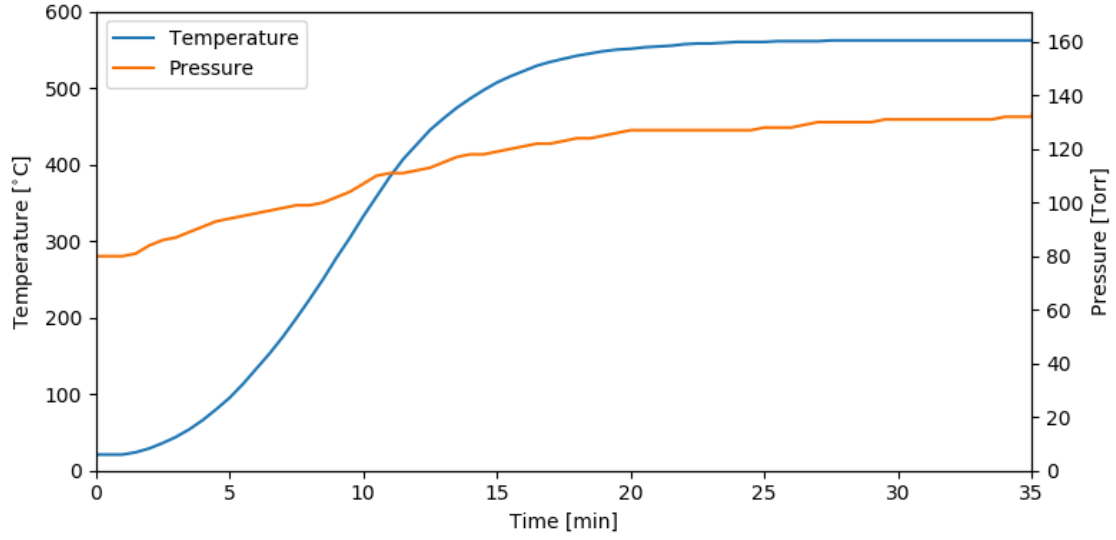


Figure 2: Temperature and pressure profile of selenisation

4 Buffer layer

1. Set circulating bath to 70°C
2. Add 183ml DI water to a beaker; leave to warm
3. When water temperature reaches 60°C:
 - Add 32.6ml NH_4OH
 - Add 25ml CdSO_4 (0.015M)
 - Start 15min timer
4. After 5mins add 12.5ml thiourea (1.5M) and submerge samples
5. When timer ends remove samples and rinse with DI water
6. Dry with compressed air

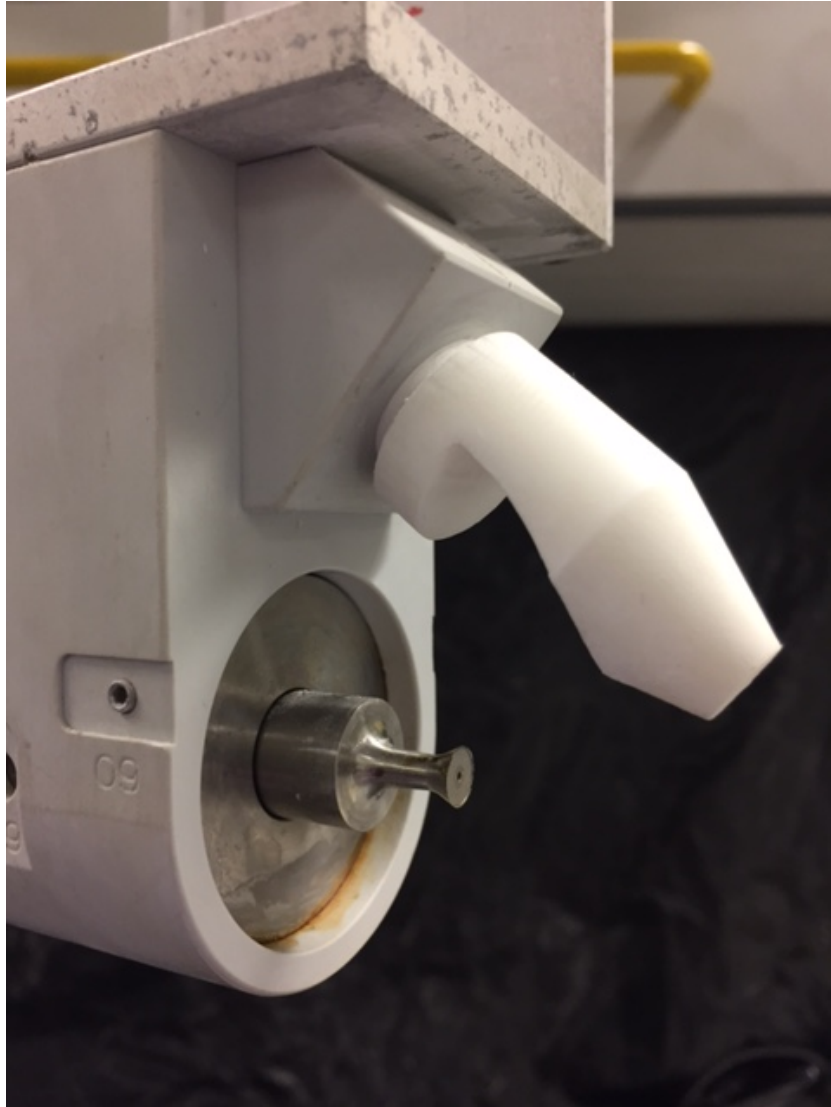


Figure 3: Photo of nozzle

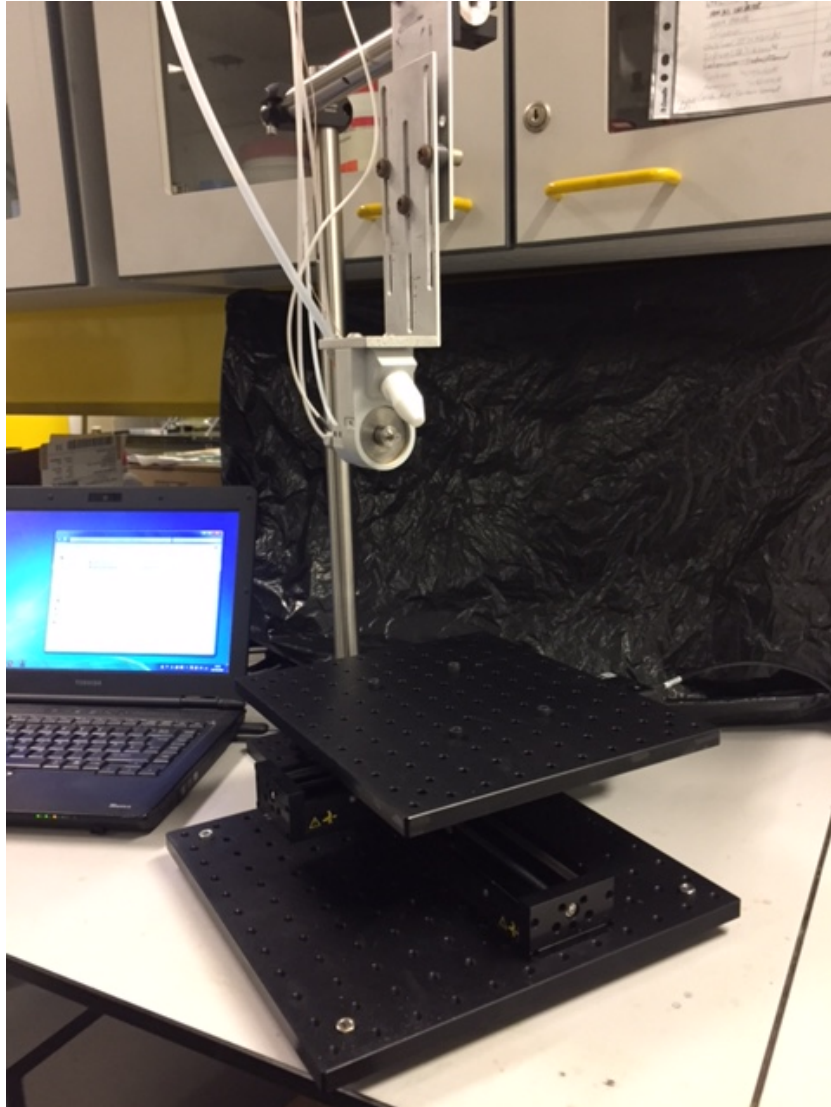


Figure 4: Photo of nozzle over stages

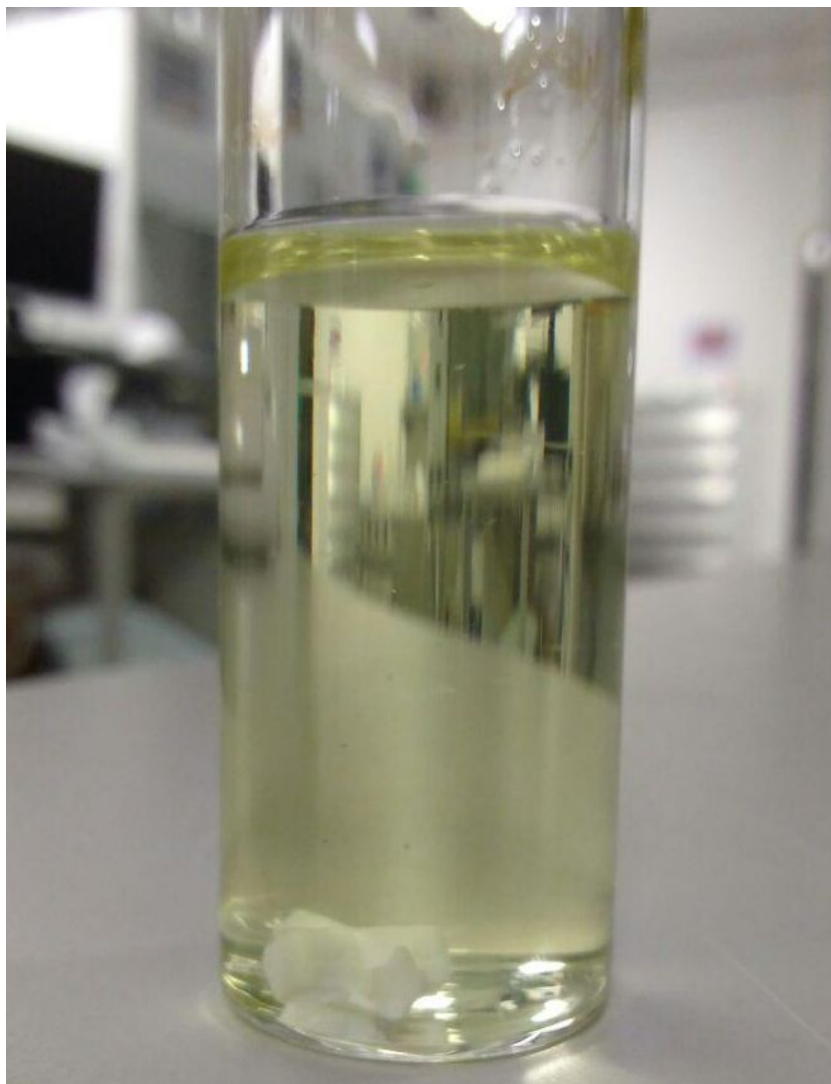


Figure 5: Photo of dissolved solution, pre-dilution



Figure 6: Photo of graphite box

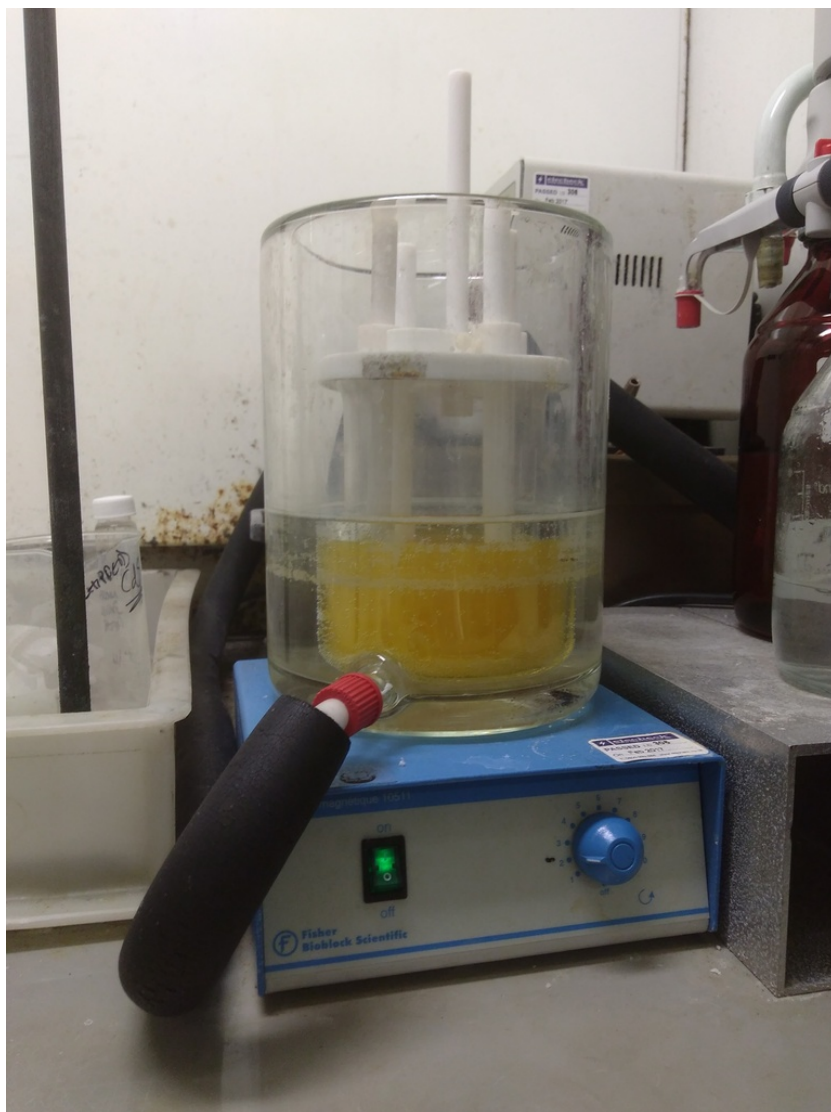


Figure 7: Photo taken during CdS deposition