

# ADHESION LITHOGRAPHY FOR LARGE-AREA PATTERNING OF ASYMMETRIC NANOGAP ELECTRODES

Dr Gwenhivir Wyatt-Moon, University of Cambridge  
gsw30@cam.ac.uk  
Andrew Flewitt, University of Cambridge

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As the resolution of devices in the electronics industry has hit the nanoscale, device fabrication costs have rapidly increased. Whilst commercial technologies such as electron-beam lithography are able to define nanoscale features, they are costly and unsuitable for large area electronics. Research is now focusing on fabrication techniques that can pattern features on the nanoscale on flexible substrates, over large areas without incurring these high costs, such as adhesion lithography (a-Lith). A-Lith is a large-scale fabrication technique for producing planar asymmetric nanogap electrodes [1]. Devices have been created with gap width:length aspect ratios >100000. The technique can be carried out in air and at ambient temperature making it ideal for the field of plastic electronics [2].

The a-Lith technique relies on a self-assembled monolayer (SAM) molecule selectively coating a prepatterned metal (M1) which then changes the adhesion forces. A second metal (M2) is then deposited over the top and can be specifically patterned when peeled using an adhesive due to its reduced adhesion on M1 relative to elsewhere. M2 only remains in the areas where there is no M1 (in the areas where it directly contacts the substrate). Where M2 fractures at the edge of M1, a nanogap ( $\approx 10$  nm) is formed between the two metals [1].

A-Lith has shown improved device performance across many areas of device electronics as the ability to pattern electrodes side-by-side largely eliminates parasitic capacitances. Such electrodes have been utilized in device applications including high responsivity photodiodes [3], nano organic light emitting diodes [4], memristors [2] and high speed diodes [5]. This fabrication technique was previously only successfully carried out with Al, Au and Ti as M1, and Al and Au as M2, with the Al and Au (with an Al adhesion layer) thermally evaporated. In this work, a-Lith has been successfully executed with a variety of materials sputtered including Cu, Ni, Ti, Mo, Cr and Al as M1. M2 is shown to be successful with Al, Ni, Cu and Cr. This has allowed for further device applications to be explored including devices utilizing 2D materials.

## References

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