



Micro-Materials Integration and Evolution in Digital Electronics Manufacturing

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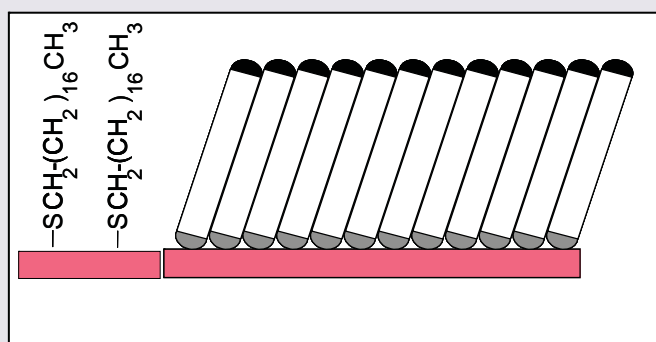
This multi-disciplinary programme proposes a feasibility study of the materials interactions and evolution during the processing and integration of complex electronics systems by means of digital manufacturing. However, instead of the printing of traditional inks, the project will specifically focus on the deposition of Self-assembled Monolayers (SAMs) by inkjet technology. SAMs are single molecule thick organic films that can be formed on surfaces from solution and are useful for controlling the chemical properties. The aim of this project is to investigate the formation of patterned SAMs on printed circuit boards (PCBs) and semiconductor wafers with ultra fine features at the microscale. In addition, the work will also investigate the subsequent processes required to form microstructures using the SAMs as resists, for electroplating or etching. Through inkjet printing trials of SAM deposition, the proposed research will investigate the following themes: i) the material characteristics and interactions during inkjet transfer of thiols carried in solutions as an ink; ii) the materials behaviour and interactions during deposition onto the substrates; iii) the performance of SAM patterns during the subsequent processes (e.g. electrolytic / electroless plating or etching). Although relatively large geometry patterns will be studied at the initial stage of the trials, the programme aims to generate features on both PCBs and wafers at sub-50 microns dimension.

Self-Assembled Monolayers (SAMs)

SAMs may be formed by alkanethiol molecules absorbed on fcc metal surfaces

They can be deposited simply by immersing the substrate in a dilute solution

Alkanethiols contain three attached chemically distinct units:



Sulphur containing head group

Hydrocarbon tail

End group: Commonly a Hydrocarbon, Alcohol or Acid

When alkanethiols are exposed to clean, oxide-free copper, the head group attaches to the surface, tethering the molecule, Figure 1a

The regular metallic structure of the copper causes the alkanethiol head groups to attach in a regular close packed pattern

This forces the hydrocarbon chains to become ordered and align in a common direction, pointing away from the copper substrate, Figure 1b

The result is a densely packed film of hydrocarbon chains presenting a tightly packed array of end-groups. As discussed below, there are various strategies to use a printed pattern of SAM to fabricate conducting tracks

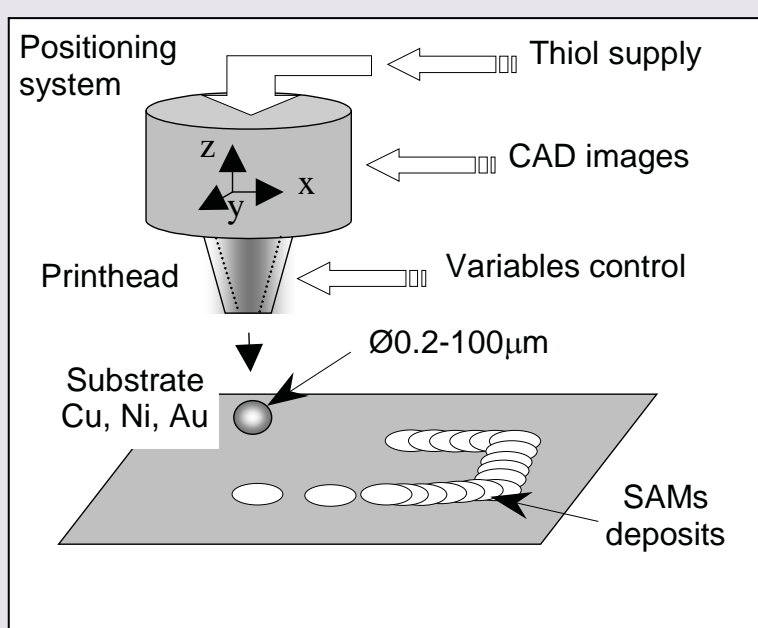


Ink-Jet Printing Technology

Ink-Jet Printing will be performed in the Drop-On-Demand mode, where individual droplets of ink are expelled at precise locations across the substrate

By depositing overlapping droplets it is possible to cover continuous regions of the copper surface

Ultimate resolution is on the micron-scale, using droplets with pico-litre volumes



Developing patterned copper with SAMs

After printing a SAM pattern various strategies can be used to result in a conducting track:

Use SAM on PCB as an etch resist

Exploit selective solder wetting of SAM coated area to produce a mask

Use SAM as a plating resist:

The current project will assess these strategies to determine their potential and feasibility