

Feasibility Project

Micro-Materials Integration and Evolution in Digital Electronics Manufacturing

Loughborough Univ., Xaar plc, Rohm & Haas Electronic Materials

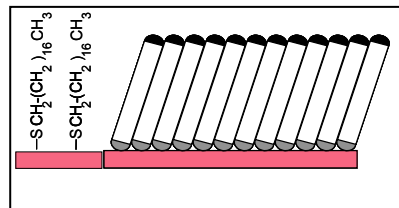
This multi-disciplinary programme proposes a feasibility study of the materials interactions and evolution during the processing and integration of complex electronics systems by means of digital manufacturing. However, instead of the printing of traditional inks, the project will specifically focus 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*

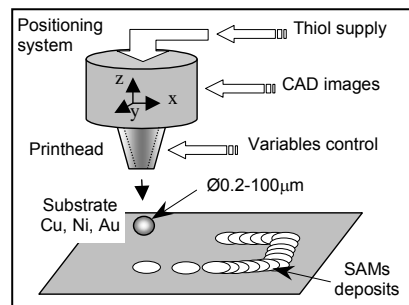
Acid

- 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

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