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Metadata Record: [https://dspace.lboro.ac.uk/2134/17072](https://dspace.lboro.ac.uk/2134/17072)

Version: Published

Publisher: National Institute of Advanced Industrial Science and Technology (AIST)

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Adhesion of Aerosol Deposition Traces Targeted for Flexible Electronics Applications

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Introduction

- Emergence of wearable electronics - from medical to consumer products.
- Requirement: To realise conductive traces on flexible substrates.
- Common printing techniques: screen printing and inkjet printing. Aerosol deposition (AD) is an emerging potential technology as it offers room temperature deposition.
- From literature others have used AD to deposit metal base layers onto flexible substrates. To the authors’ best knowledge, there has been no work reported on the deposition of copper onto flexible substrates.
- Copper is an attractive option as it is relatively cheap compared to other metals (eg. silver).

Goal

- Investigate adhesion of copper (Cu) powders (≤2μm) deposited on glass substrates using AD.
- Glass is considered so as to understand the parameters influencing the AD process. Furthermore, if the trace can adhere to glass slides, it would be able to adhere to other types of substrates.
- Samples considered:
  (a) Cu particles deposited on smooth glass.
  (b) Cu particles deposited on roughened glass.
  (c) Ceramic particles (Lithium manganese oxide) deposited on glass.

Approach

- AD Parameters on glass:
  - Sample placed in ultrasonic bath (2 mins).
  - Heating at 110°C, 30 mins.
- Adhesion Test #1
  - ISO Tape test
- Adhesion Test #2
  - Cross hatch test (1mm grids made)
- Rating of adhesion using ISO grading scale

Key Results

(a) Smooth glass
- After tape test #1: Residue on ISO tape
- Most of the copper film is detached ⇒ minimal adhesion

(b) Roughened glass
- After tape test #1: Residue on ISO tape
- Adhesion of Cu with glass interface improved, but inhomogeneous anchor layer obtained

(c) Smooth glass
- After tape test #2 (Cross-cuts made): Residue on ISO tape
- Best adhesion obtained. Adhesion test #2 yields ISO rating of 1

Conclusion

- The adhesion of copper particles deposited onto smooth and roughened glass was investigated. The results were compared to LMO particles deposited on smooth glass.
- The results obtained suggest that the combination of particle hardness and substrate hardness/roughness affects the quality of the base layer deposited.

Future Work

- To improve on the Cu particle-substrate interface adhesion by:
  (a) Increasing the impact velocity of the copper particles.
  (b) Modifying the substrate surface.
- To compare the adhesion of AD traces with other printed traces.

Acknowledgement

This research was carried out as a collaboration between Loughborough University and AIST. The authors would like to acknowledge the 7th European Community Framework Programme for financial support through a Marie Curie International Research Staff Exchange Scheme (IRSES) Project entitled “Micro-Multi-Material Manufacture to Enable Multifunctional Miniaturised Devices (MiM)” (Grant No. PIRSES-GA-2010-269113).

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