SAND2017-7705D

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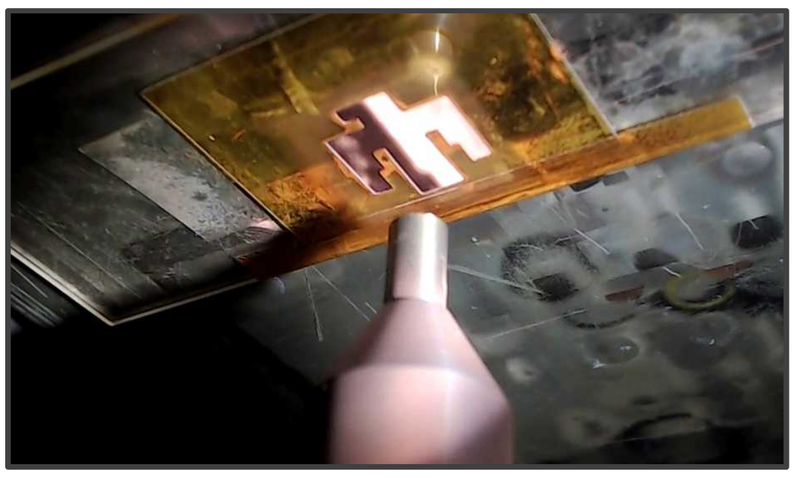

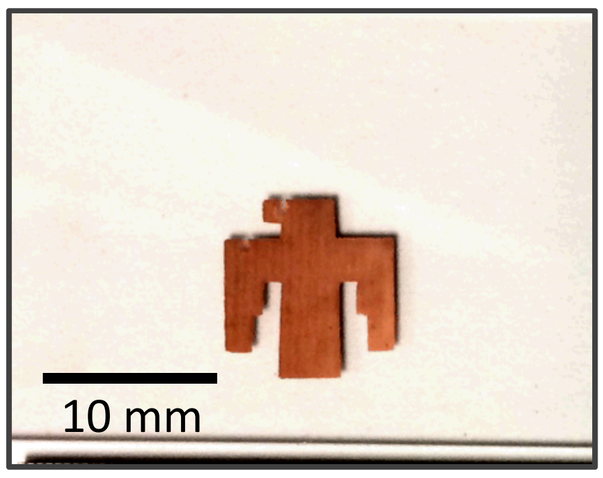

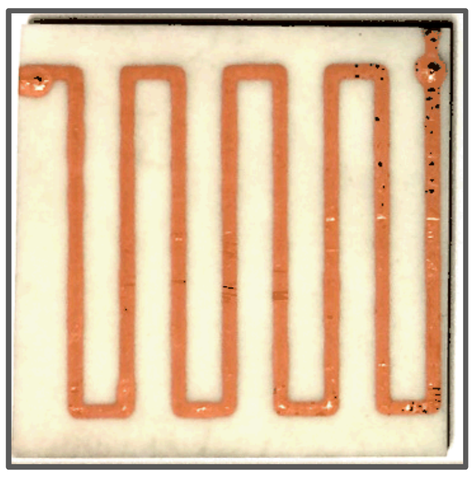

Conductivity of Aerosol Deposited Copper

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Abstract

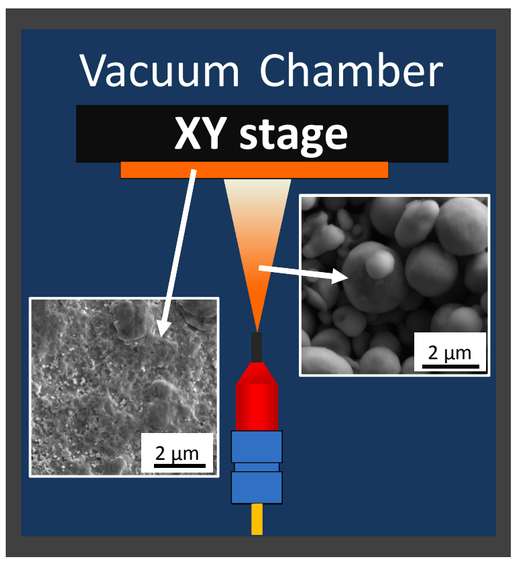
Conductive copper traces deposited by aerosol deposition are measured by contact profilometry and a four point probe to quantify the conductivity. Conductive traces were found to be uniform in cross-sectional area, but conductivities were 10-25x lower than bulk copper.

Introduction

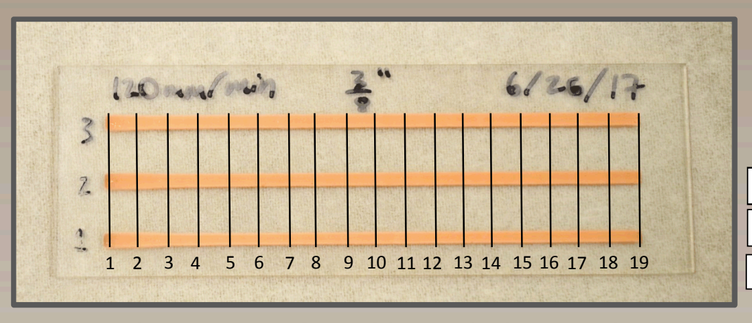
Aerosol deposition (AD) is a room temperature deposition method which uses dry powder for thick film deposition of metals and ceramics. AD utilizes the impact of small particles (<5 um) to cause plastic deformation and bonding, allowing for a thick film with a dense microstructure to be deposited. Copper films deposited by AD are dense and conductive as-deposited, removing the need for in-situ or post-deposition annealing required by liquid suspension based deposition technologies. Conductivity measurements are used to quantify and improve the performance of AD Cu films giving insight into their usage in microelectronics and power applications.

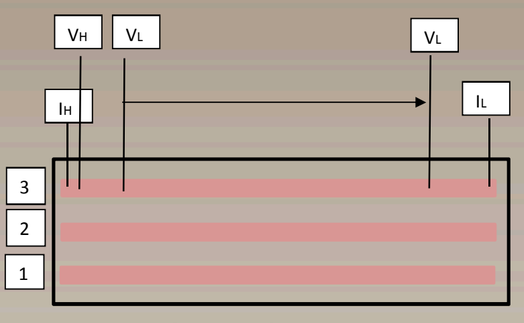
Methods

A total of six copper traces were deposited on glass from starting powder with a D50 of 1.5 um. A rotary brush dry powder feeder and compressed air were used to generate a uniform aerosol which was sprayed onto a glass substrate using a round 0.080” nozzle.



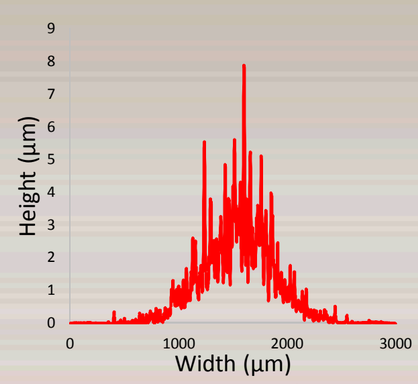
Copper Aerosol Deposition



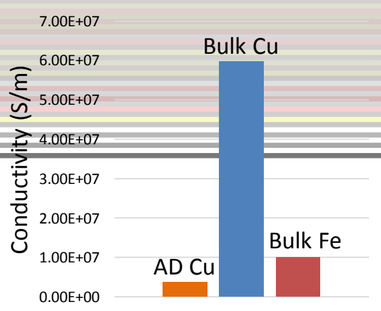


Schematics of profile and electrical measurements performed on traces.

Profiles of the traces were measured on a Dektak Profiler every 3.5 mm along each trace to obtain the cross-sectional profile. Profiles were integrated to find the area for conductivity calculations. Impedance measurements were taken using a HP Precision LCR Meter and a four-point probe, every 3.5 mm along each trace, using a 1V source at 100Hz. Uncertainty values based on these measurements were calculated.



Dektak Profile



Relative Conductivities

Results & Discussion

The deposited copper traces were continuous and well-adhered to the glass substrate. Conductivity measurements of the traces were 10-25x below that of bulk copper. Oxidation of copper powder during handling and deposition is likely to produce copper oxides which reduces the conductivity of the copper traces.

Conclusion

Aerosol deposition can be used to deposit conductive films, but the resistance is high. Future work will focus on improving the electrical conductivity of AD Cu by reducing the oxide content, changing particle size, post-deposition annealing, and in-situ thermal treatments.

U.S. DEPARTMENT OF ENERGY
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